How BIM enables more sustainable construction and more energy-efficient buildings

الورشة الثانية - الاسبوع الخامس

(PhD Course 2023-2024)

عمر سليم

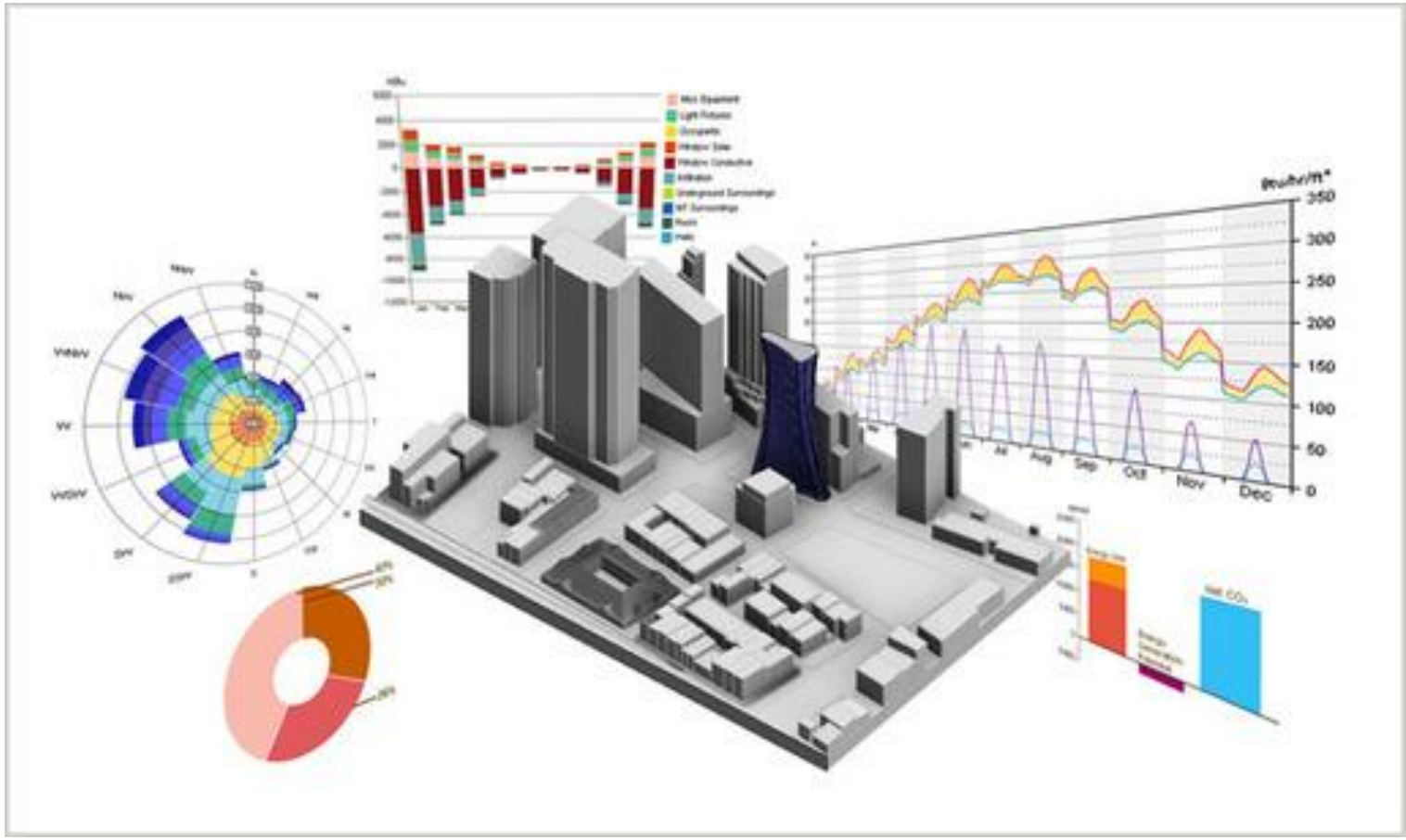
I am Omar Selim
Founder of BIMarabia
- BIM Manager
- CAD / 3D Visualization
- Specialist / CAD Manager / BIM Instructor / Technical Support Manager
- Member of IBPSA (International Building Performance Simulation Association),Engineers For a Sustainable Egypt
- Research assistant at Qatar University
- This experience includes architectural drawings , architectural planning and detailing. Expert user in Revit, NAVISWORKS, AutoCAD and QTO.
- I have been working in many projects using BIM technique starting from the Conceptual Design up to Construction documents, this projects include a lot of types, such as Hotels, mixed use building, Hospitals , Mosques, Villas

I am here because I love to share Knowledge.

You can find me at @BIMarabia

Sustainability

- - Development “meeting the needs of the present generation without compromising the ability of future generations to meet their needs.” – Brundtland Report



Why sustainability?

We need to build sustainably to:

1. Preserve our environment
2. Reduce the buildings' costs
3. Increase efficiency & durability
4. Provide healthy environments for people

"Building Design and Construction: Forging Resource Efficiency and Sustainable Development", United Nations Environment Program-Sustainable Buildings and Climate Initiatives (UNEP-SBCI)

الفوائد البيئيَّة على المستوى العالمي:

- يعدُّ قطاع البناء المساهم الأكبر في انبعاثات غازات الاحتباس الحراري مقارنةً بالمصادر الأخرى؛ وبالتالي فهو المساهم الأكبر في التَّقليل من هذه الانبعاثات.
- تقدَّر كمية الانبعاثات التي يُمكن التَّخلص منها بـ 84 غيغا طن من غاز Co2 حتى عام 2050، ويتعلق ذلك باتخاذ تدابير مباشرة في المباني تتمثل في كفاءة استهلاك الطَّاقة، والاعتماد على وقود صديق للبيئة واستعمال مصادر الطَّاقة المتجددة.
- حفظ 50% وأكثر من الطَّاقة المستهلكة في الأبنية، الأمر الذي يسهم في تقليل معدّل ارتفاع درجات الحرارة إلى أقل من درجتين مقارنةً بعصر النهضة الصِّناعيَّة.

الفوائد البيئيَّة على مستوى البناء مقارنةً بالأبنية التَّقليديَّة :

- أظهرت الأبنية الحاصلة على شهادة النجمة الخضراء Green Star في استراليا أنّ انبعاثات الاحتباس الحراري الناتجة عن هذه الأبنية أقل من نظيرتها التَّقليديَّة بمقدار 62%، كما أنّ استهلاكها لمياه الشرب أقل بـ 51%.
- توّفر الأبنية الخضراء المعتمدة من قبل مجلس البناء الأخضر الهندي the Indian Green Building Council (IGBC) ما مقداره 40-50% من الطاقة، و20-30% من المياه المستهلكة.
- تخفض الأبنية الخضراء الحاصلة على شهادة النجمة الخضراء Green Star في جنوب أفريقيا كلّ من استهلاك الطاقة وانبعاثات غاز CO2 بمقدار 30-40%، و20-30% بالنسبة لمياه الشرب، وذلك بمعدلٍ سنوي.
- كما تستهلك الأبنية الحاصلة على شهادة LEED في كلٍّ من الولايات المتحدة وبلدان أخرى طاقةً أقل بـ 25%، ومياه شرب أقل من 11% مقارنةً بالأبنية التَّقليديَّة.

How can a Buildings be sustainable?

Sustainable Buildings are designed and constructed to perform effectively while:

1) Minimizing energy requirements
2) Reducing water consumption
3) Reducing carbon footprint
4) Using materials that have low environmental impact
5) Reducing wastage
6) Conserving the natural environment
7) Safeguarding human health and wellbeing

Sustainability of a building is influenced by:

– Building performance
– Environmental, economical & social impacts

BIM advantages include:

– Ability to analyze
– Ability to evaluate green buildings
– Access to information to make sustainable decisions

Sustainable Construction and Buildings

1. Buildings use 46% of all energy – up to 70% in major cities
2. Construction uses 53% of primary materials
3. Construction has second biggest environmental footprint after food
4. 13 million tonnes of materials delivered and not used
5. 90 million tonnes of waste – 3 times domestic output
6. 21% of all hazardous waste in UK is construction waste
7. 92% of clients said that designers' drawings are typically not sufficient for construction
8. 37% of materials used in construction become waste
9. 10% of the cost of a project is typically due to change orders
10. 38% of carbon emissions are from buildings not cars

Why accept this ?.....

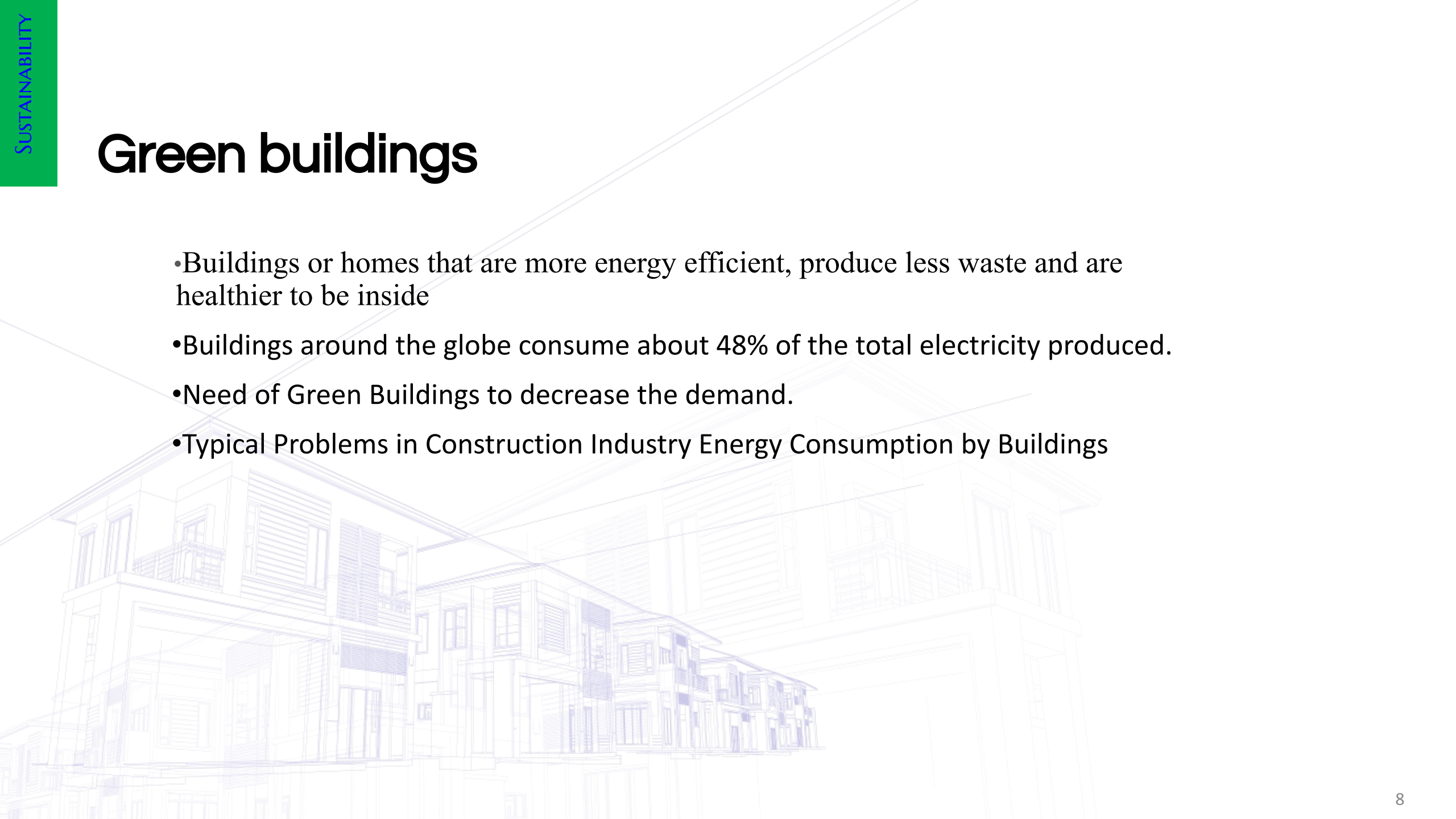
CMAA Owners survey 2005, CMAA Industry Report 2007, Economist Magazine 2002
Buildings contribute 40% of global carbon emissions.

The UK government's Construction 2025 strategy targets a 33% reduction in the whole-life cost of built assets and a 50% reduction in greenhouse gas emissions by 2025.

This is a stepping stone on the way to the target of cutting emissions by 80% by 2050 (compared with 1990 levels).

Green buildings

- Buildings or homes that are more energy efficient, produce less waste and are healthier to be inside
- Buildings around the globe consume about 48% of the total electricity produced.
- Need of Green Buildings to decrease the demand.
- Typical Problems in Construction Industry Energy Consumption by Buildings



Benefits of Green Building

•Environmental benefits:

–Enhance and protect ecosystems

–Improve air and water quality

–Reduce solid waste

–Conserve natural resources

•Economic benefits:

–Reduce operating costs

–Enhance asset value and profits

–Improve employee productivity and satisfaction

–Optimize life-cycle economic performance

•Health and community benefits:

–Improve air, thermal, and acoustic environments

–Enhance occupant comfort and health

–Minimize strain on local infrastructure

–Contribute to overall quality of life

Sustainable Design

Energy

Lighting and equipment

Heating, cooling, and ventilation

Occupant processes

- Minimize operating energy
- Utilize renewable energy
- Select and design site

Water

Potable supply for occupants

Non-potable supply for processes

Storm water runoff

- Reduce water use
- Reclaim gray water
- Manage Hydraulics and Hydrology (H&H)

Materials

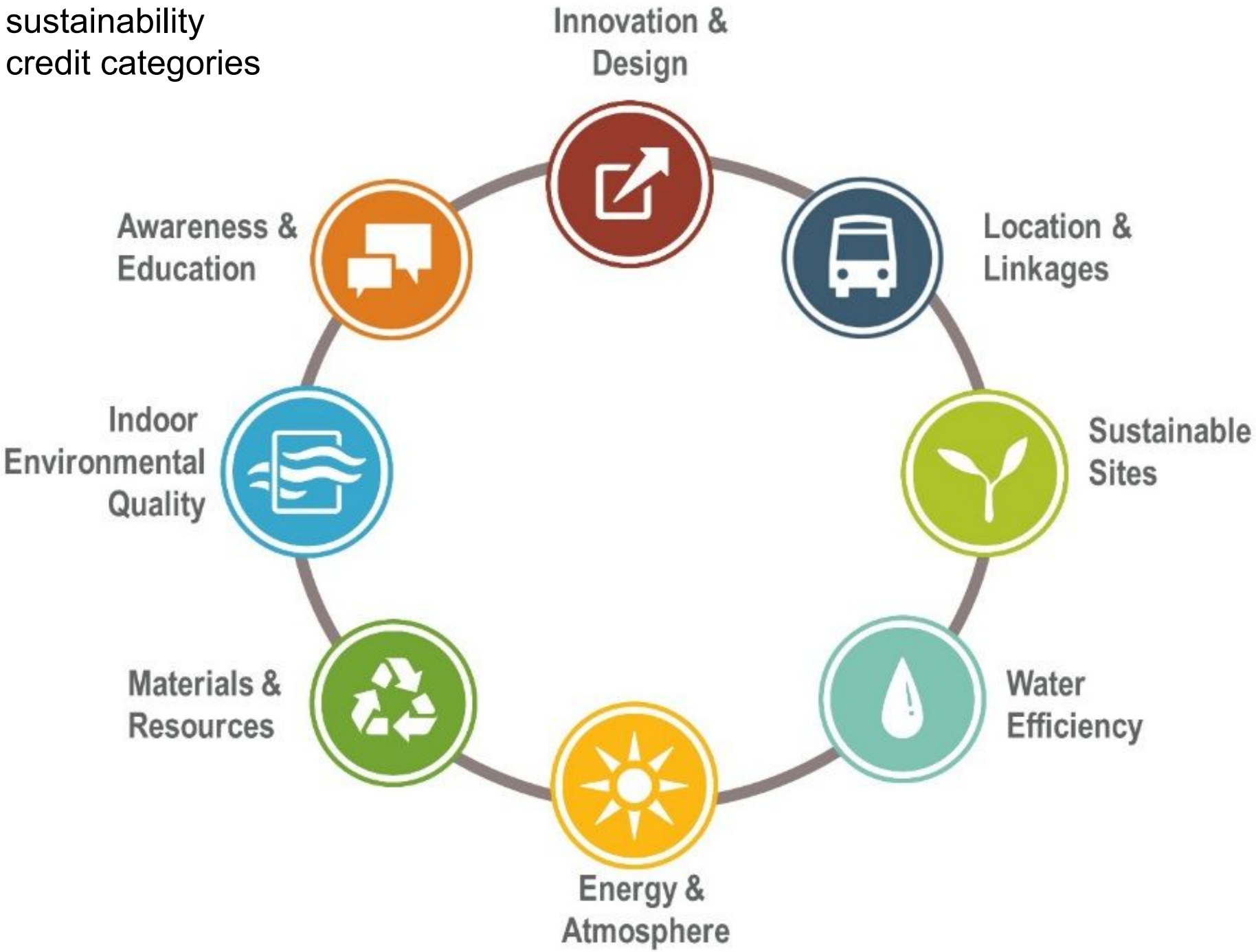
Site work

Structure, envelope, and finishes

Furnishings and equipment

- Implement low impact development
- Seek renewable sources
- Minimize embodied measures

sustainability
credit categories

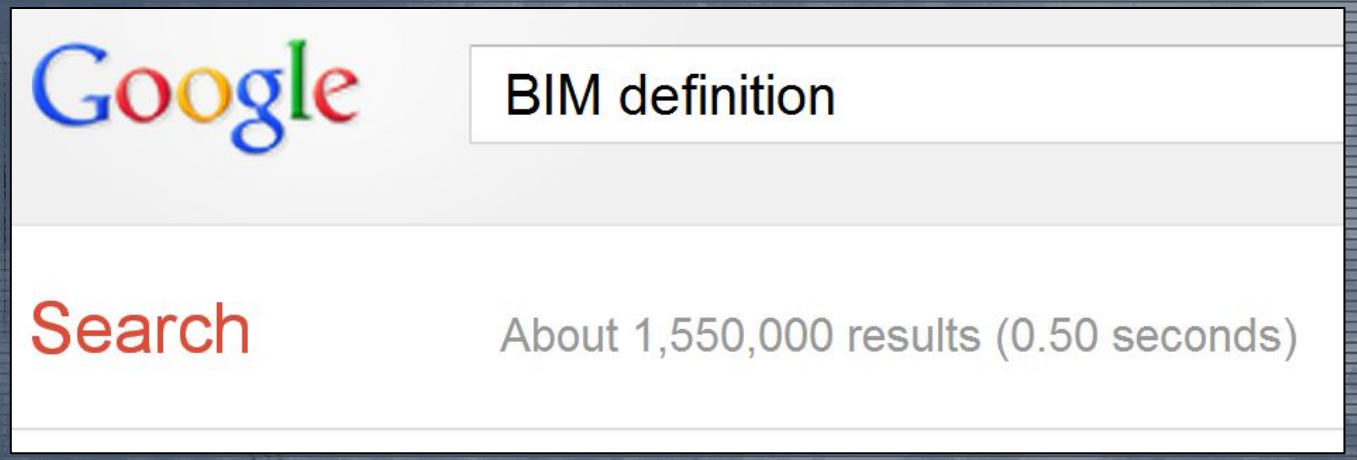


What is BIM?

Building Information Modeling

Building Information Management

Better Information For Management.



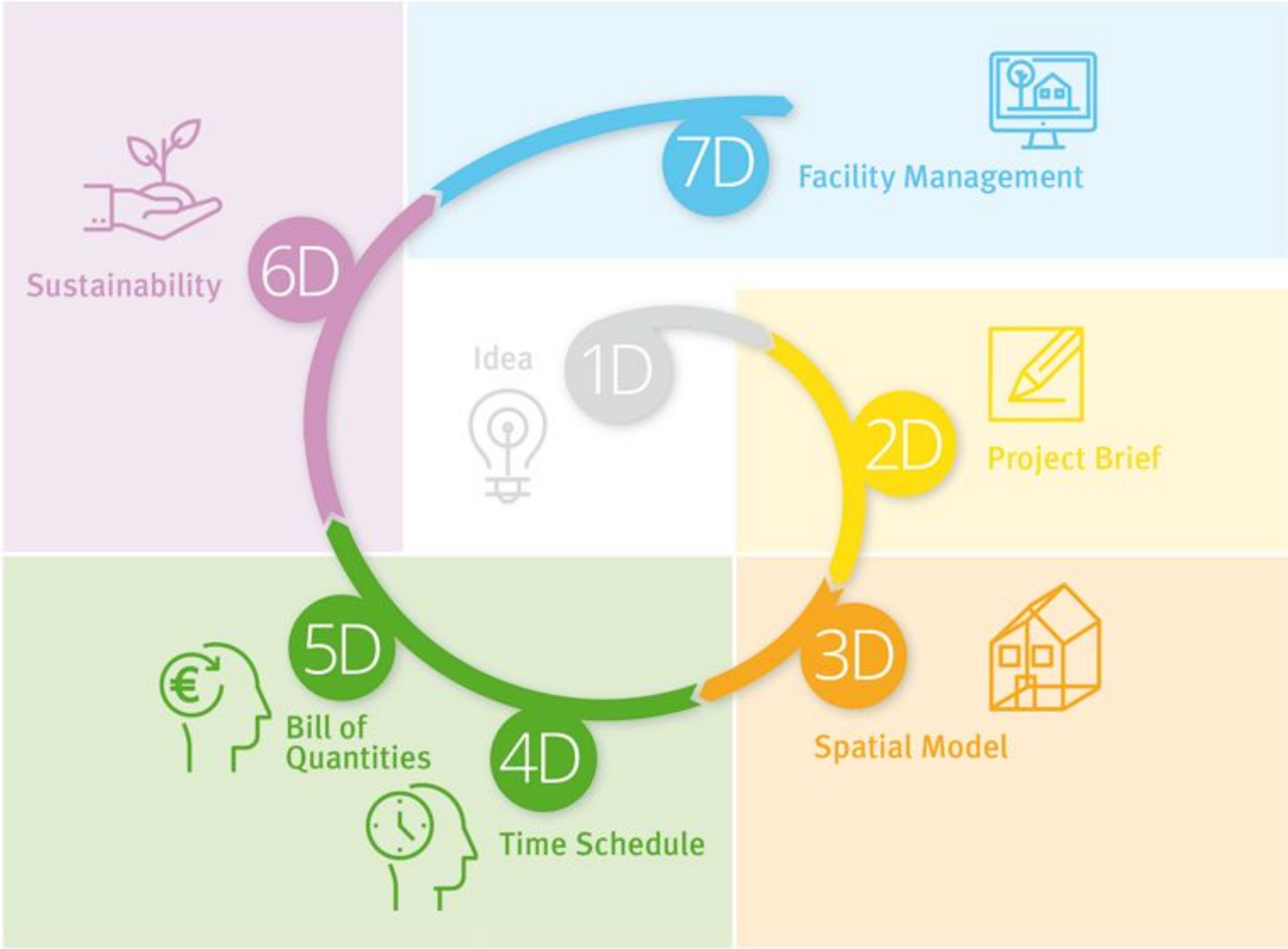
"is a process supported by different tools, technologies and contracts involving the generation and management of a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward."

Why BIM ,,Benefits of BIM,,

What is the added value that BIM can provide to sustainability ?

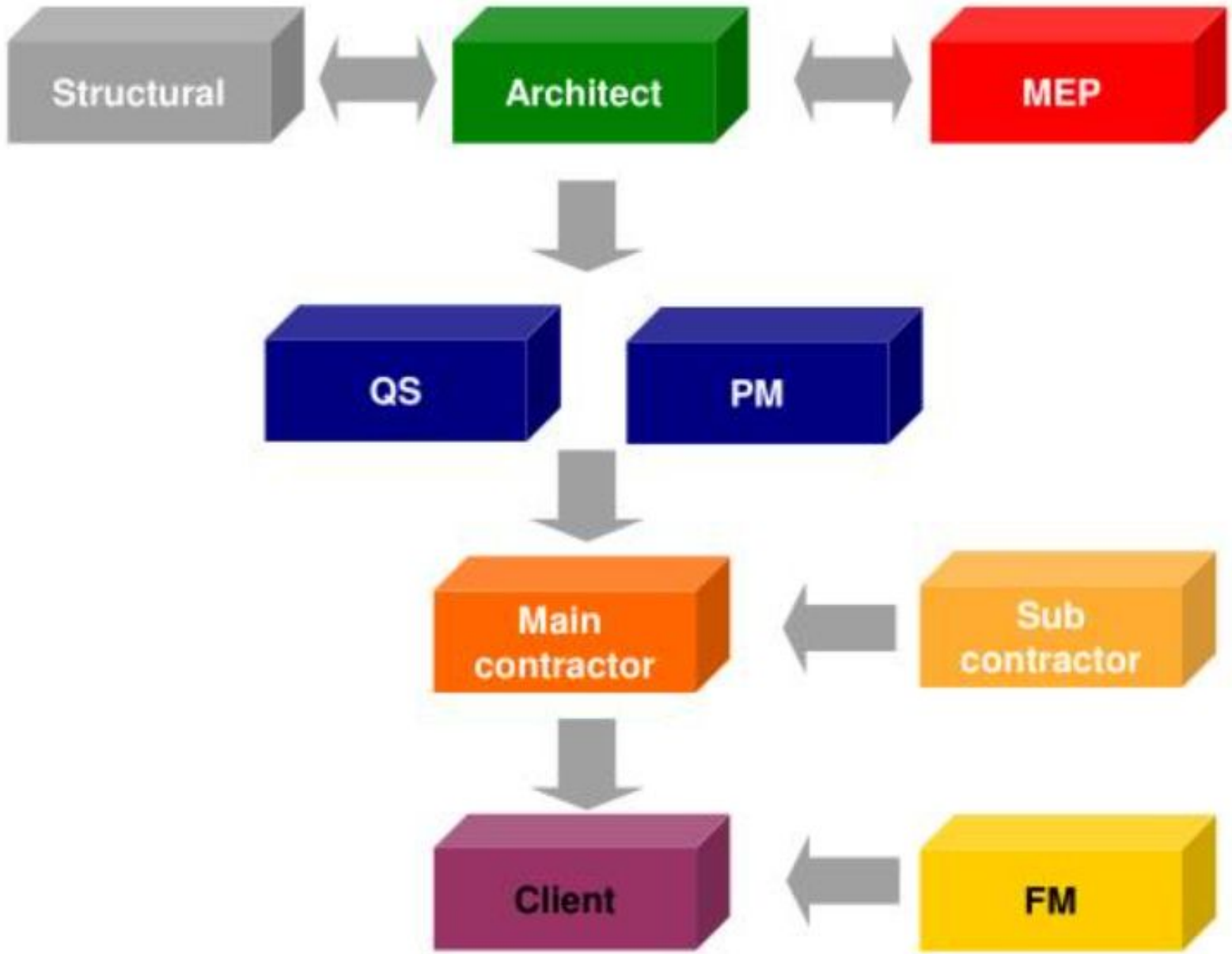
- Decision making
- Rating compliance
- Building Performance
- 3d visual information
- Numerical information
- Data linking transfer
- REM : Rapid Energy Modelling
- Analysis
- Cloud computing

BIM Dimensions

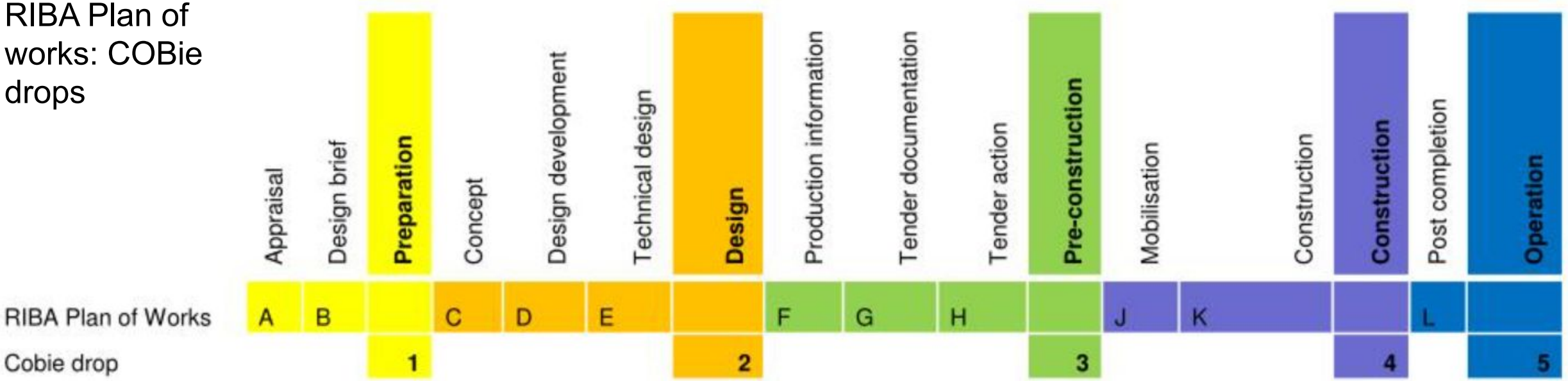


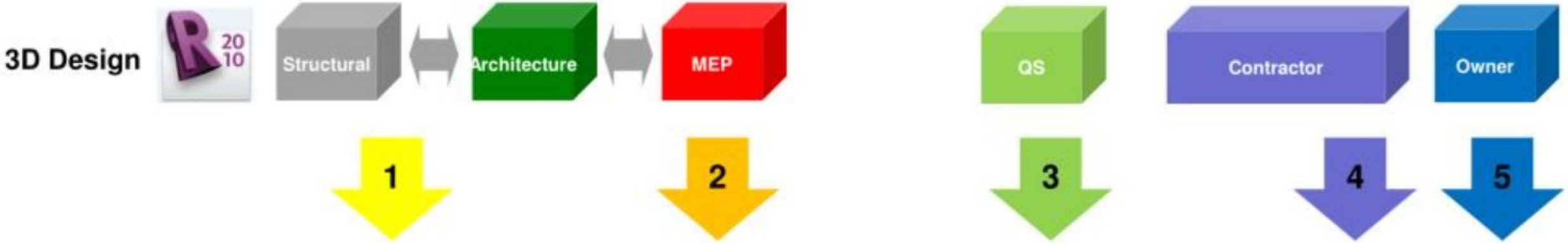

GATE 6
GATE 2
Appearance ...
Excavate Cap
Install Rebar
Metal Decking
Pour concrete
Steel detailing
Waterproof

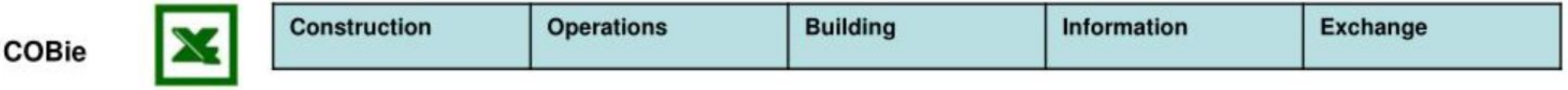
Collaboration



RIBA Plan of works: COBie drops







Design phase

1.Coordination & Collaboration

2.Visualization

3.Performance Analysis & Evaluation

Performance Analysis & Evaluation
•Merge of Design & Analysis = optimize building performance
•Better quality of data = minimum errors and miscalculations

1.Coordination & Collaboration

How?

- Integrate Sustainable aspects with BIM processes.
- (All team members on board from the beginning.)
- Access to information
- One central model = Clash detection (No Ad hoc solutions on site)
- Team member makes a change, all other disciplines are aware and can adjust their parts accordingly

Visualization

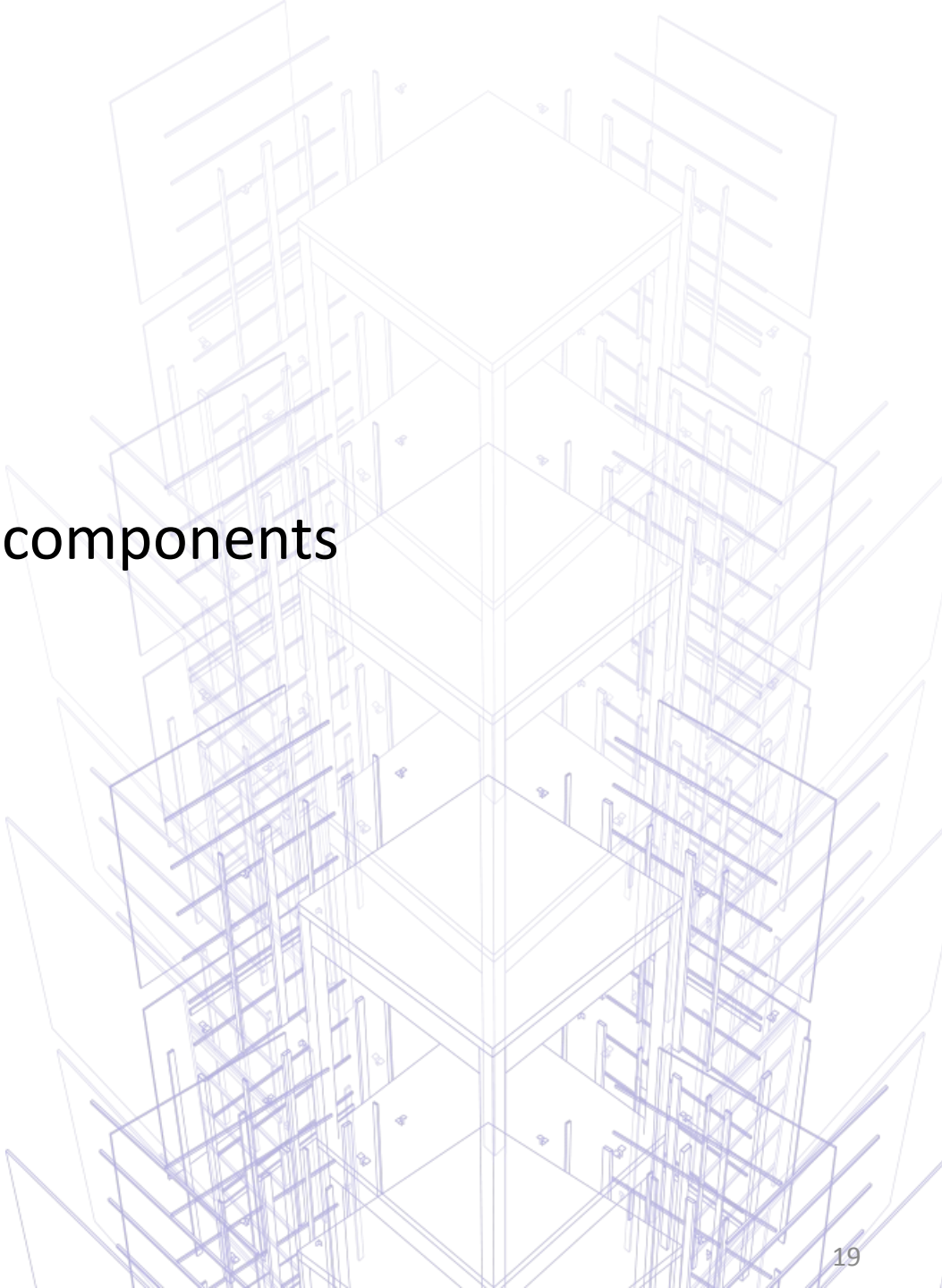
- Design options
- Better engineering decisions
- Clear picture for the owner
- Design changes without delay of time or increase of cost

Design process that includes:

- Collaboration of disciplines
- Digital model
- Analysis & comparisons
- Information & properties of all building components

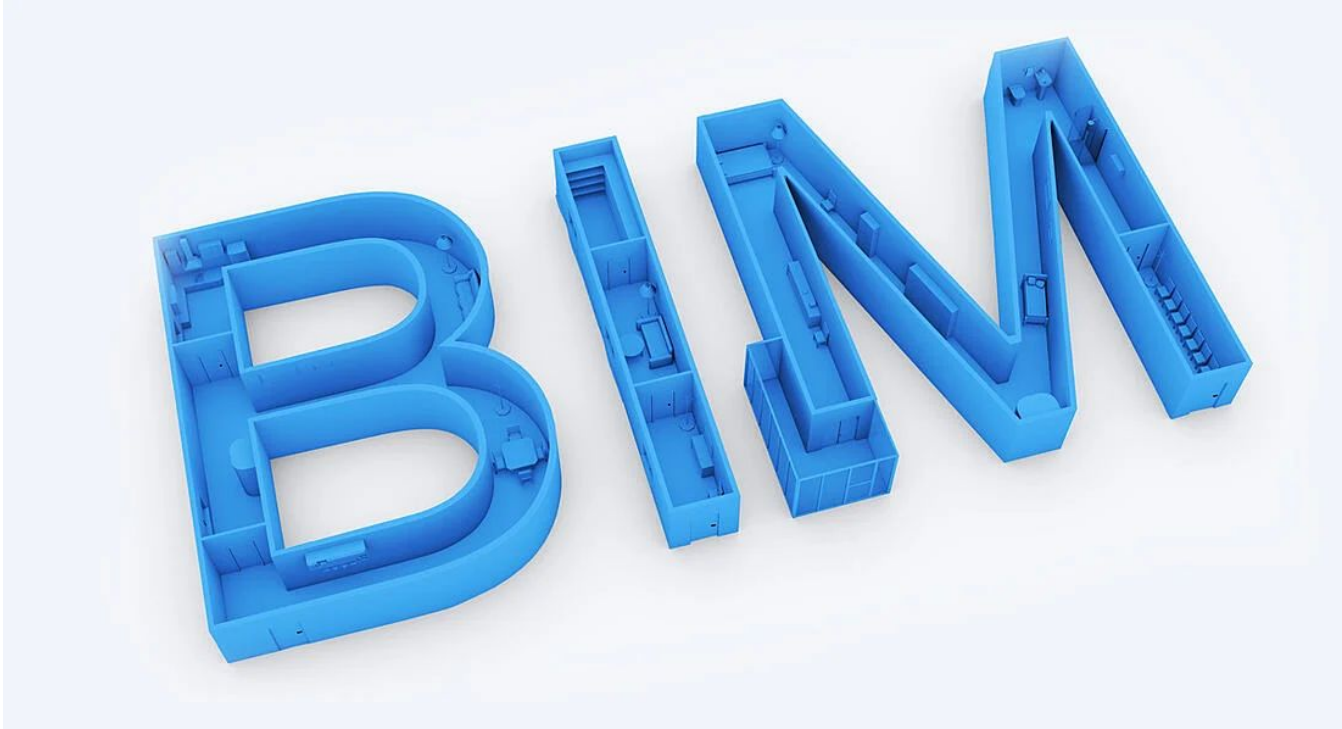
Know how's :

1) How to better put a building together?
2) How building should perform?
3) How it might be taken apart?



Construction Phase

1. Continuous analysis for environmental effects
2. Thorough design details
3. Material take-offs

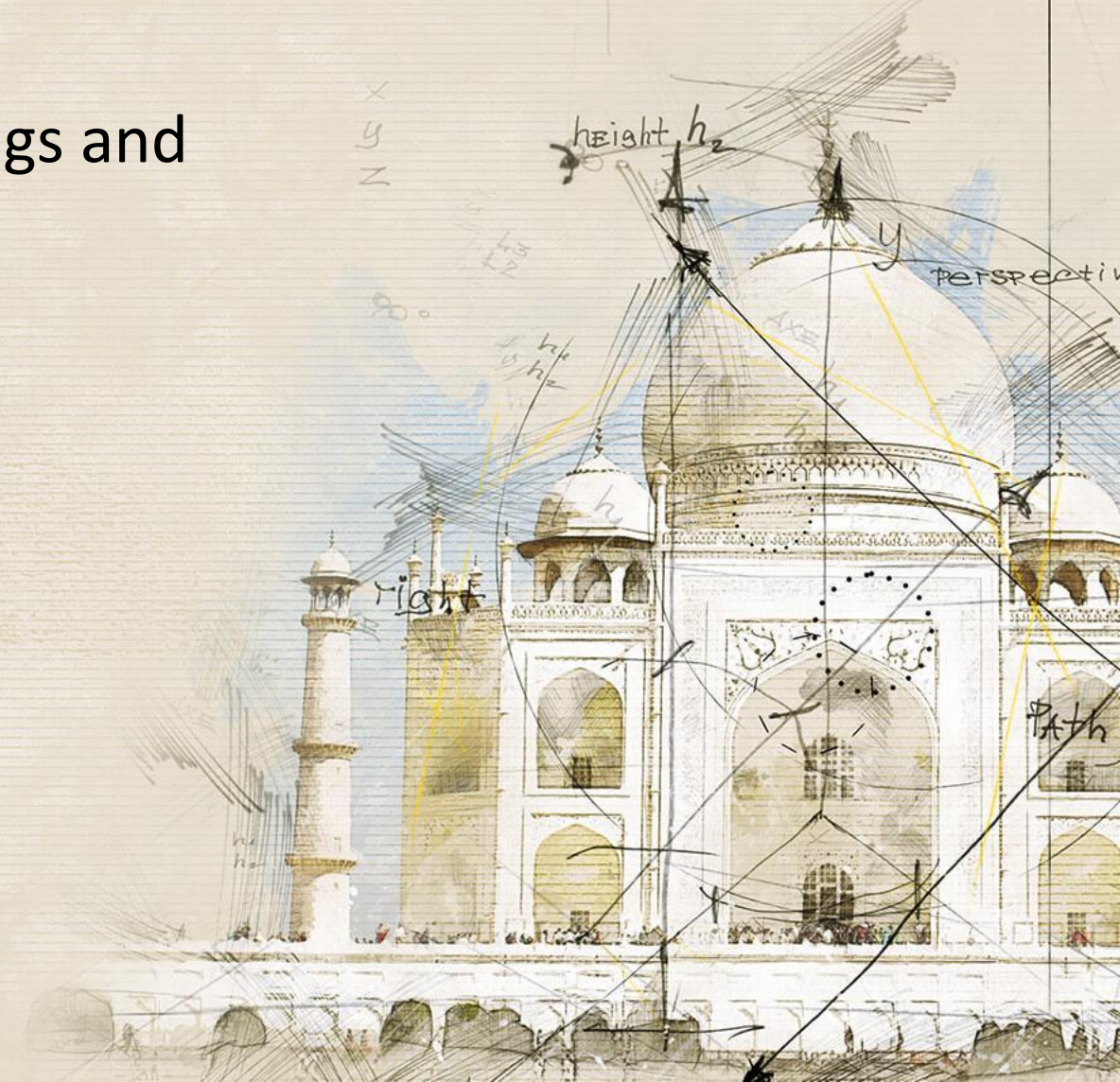


Construction Phase Continuous Analysis

•Construction effects on the surroundings and environment measuring:

- Energy use
- Noise pollution
- Any environmental effect

Propose methods to lower results



Construction Phase
Design details

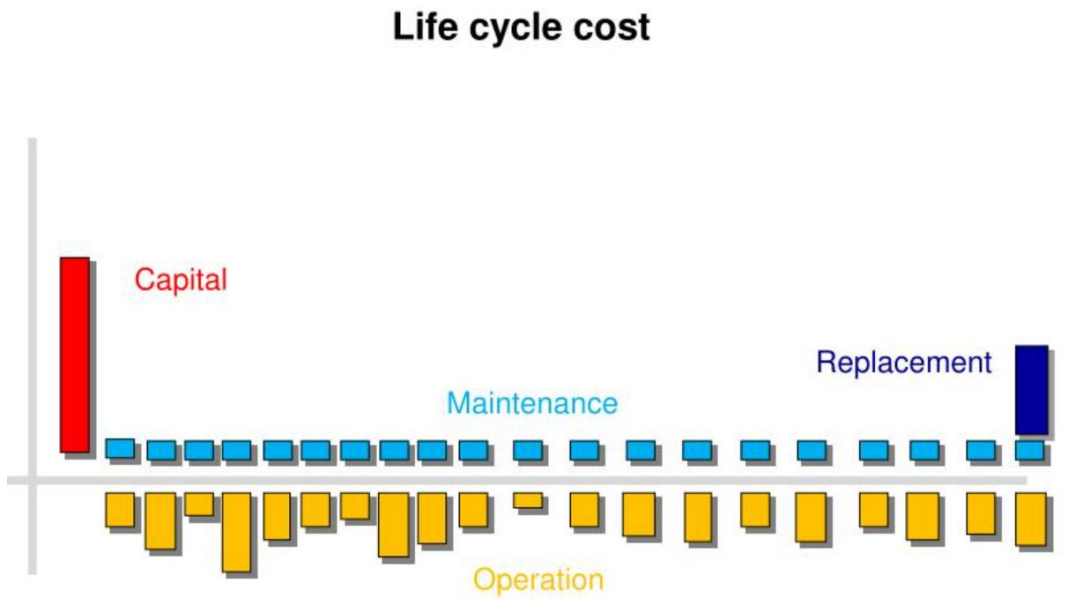
- Drawing in 3D allows sections and details to be made ready for construction
- By minimizing construction defects, the ongoing operational costs are reduced & end up with a faster, safer construction

Construction Phase
Detailed material take-offs

- Offsite fabrication eliminates
- over ordering
- reduces waste
- allows off cut materials to be reused or recycled
- Components will fit together on site and they have been fabricated using a co-ordinated model
- Fewer deliveries to and less waste removal from site reducing

Operation Phase

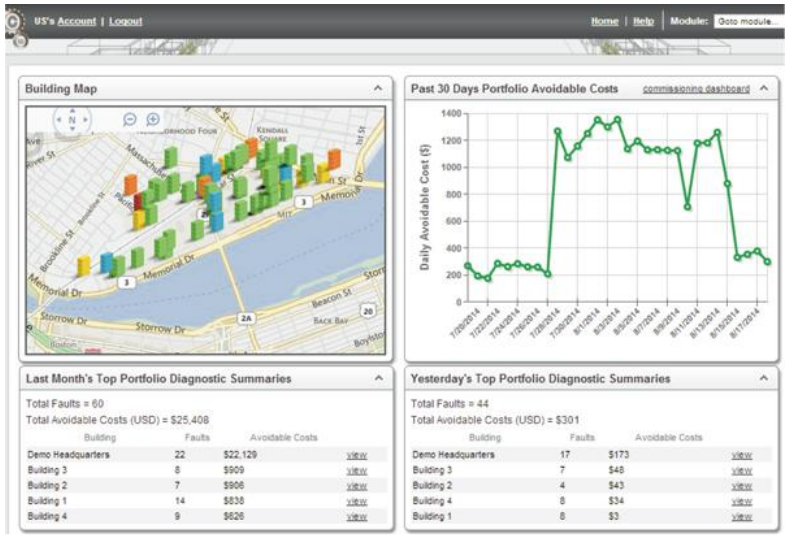
1. Monitoring & recording building performance
2. Updated alterations & changes to the building
3. Seasonal commission and maintenance
4. Access to sustainable information



Monitoring & recording building performance

Monitoring & recording building performance in terms of:

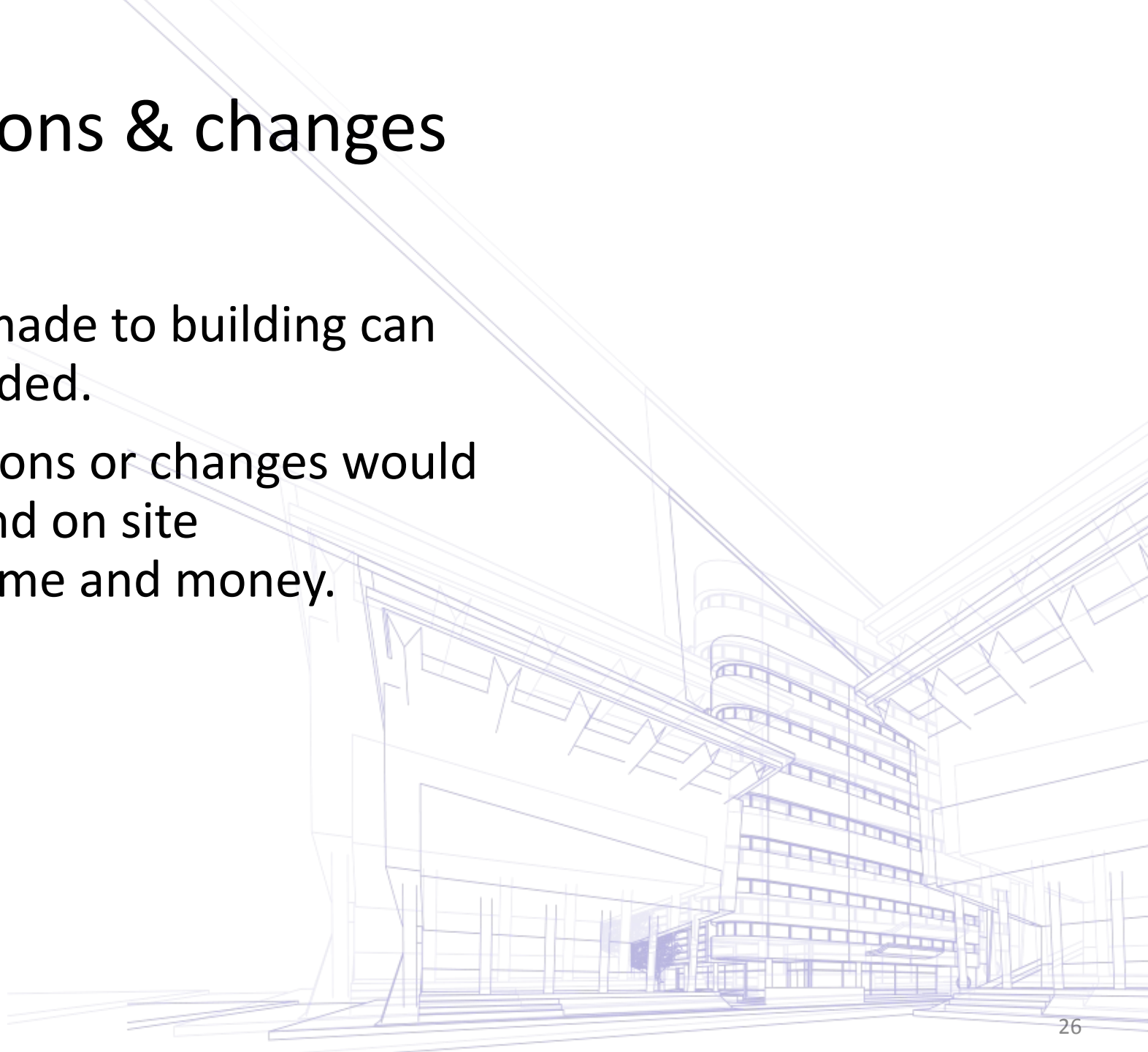
- Water / wastewater
- Energy
- Carbon Emission
- Comparison of actual X intended
- Better decisions for improvements after the results
- Reduce resource & waste consumption (recycling)



This mockup shows what the Clockworks energy report for MIT looks like online. The numbers shown are for illustration purposes only. Image: KGS Buildings

2) Updated alterations & changes to the building

- Additions/ adjustments made to building can be easily tracked and recorded.
- Traditionally, any alterations or changes would repeatedly need surveys and on site investigations which cost time and money.



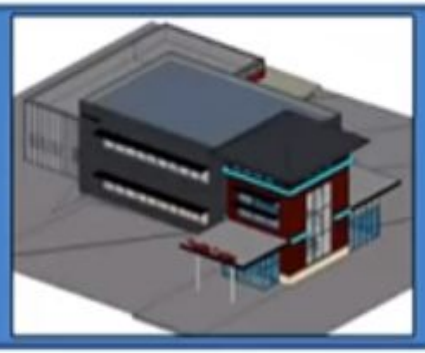
3) Seasonal commission & maintenance

• Plan maintenance activities that can be synchronized minimizing cost and disruption of occupants

4) Access to information

• Engage occupants and management with access to sustainability information and dashboards in their buildings

BIM
Building Information Modeling

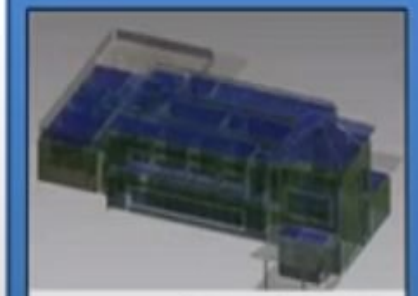


- Visualization
- Structural analysis
- Cost
- Documentation
- Fabrication/Construction
- Etc...

Building Performance Analysis (BPA)

Whole Building Energy Analysis

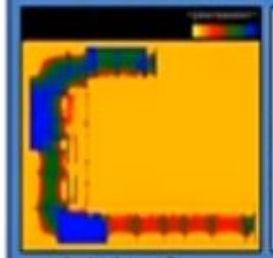
- Conceptual Models
- Detailed Models



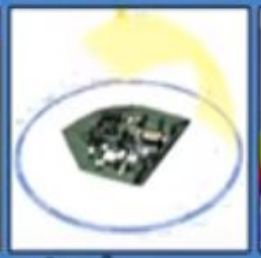
Energy Analysis Model (EAM)

+

Other Performance Studies

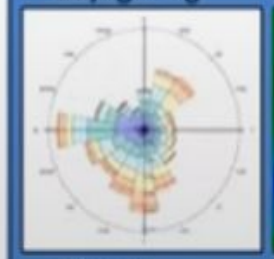


Lighting & Daylighting

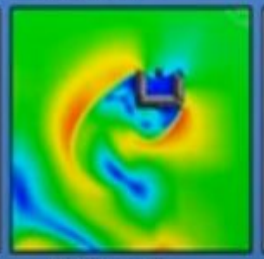


Sun & Shadows

Solar Radiation

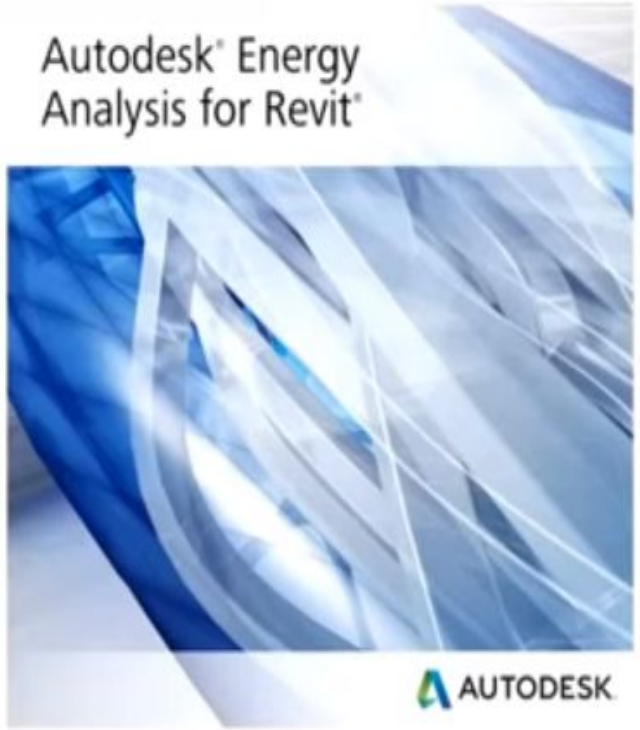


Climate Analysis



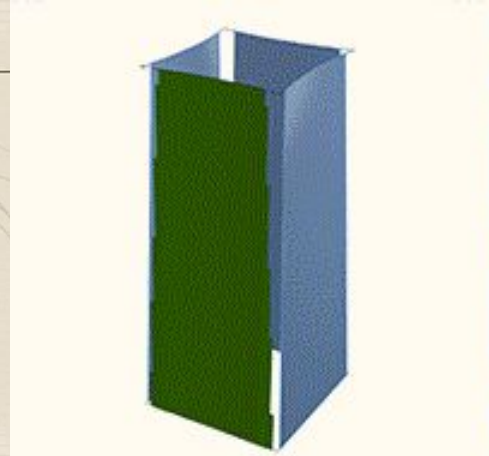
Airflow & Ventilation

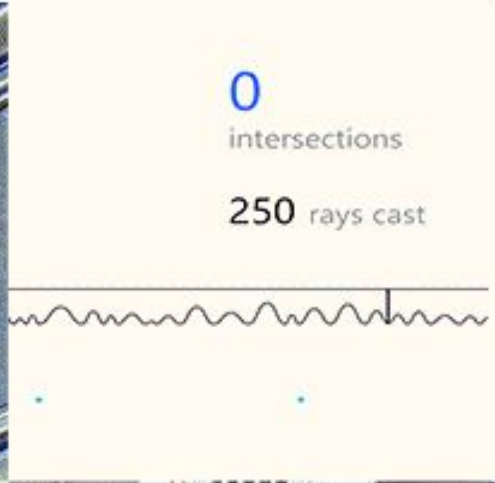
Lifecycle Analysis

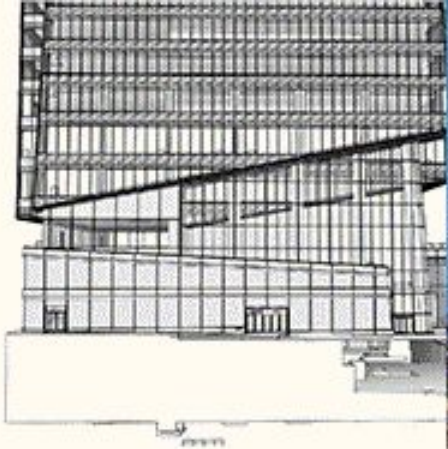


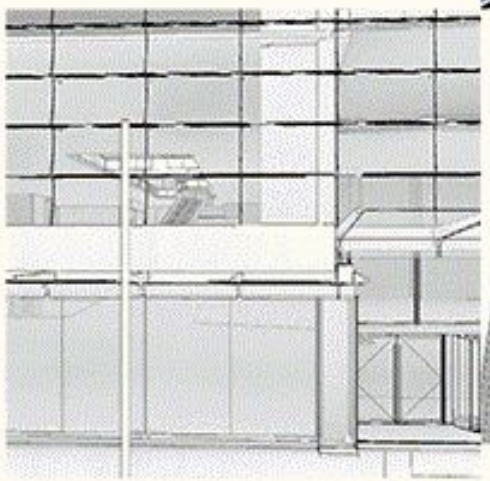
- Performance-based Design Studies

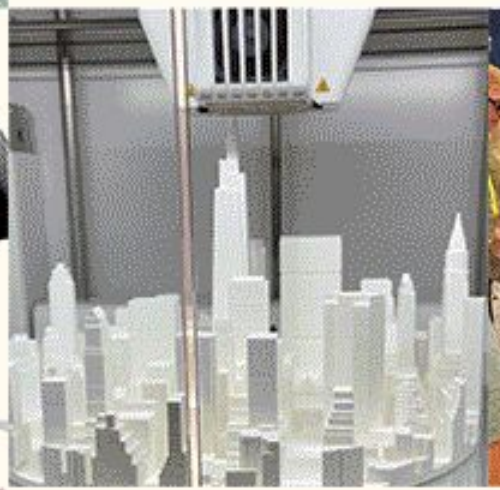
BIM

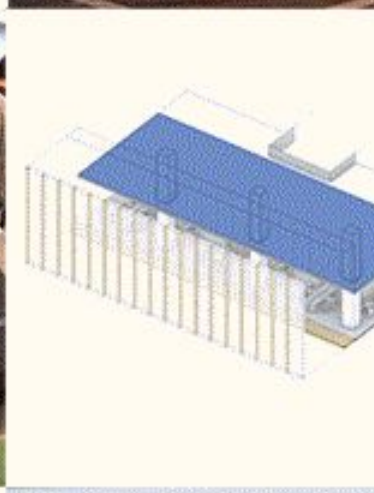


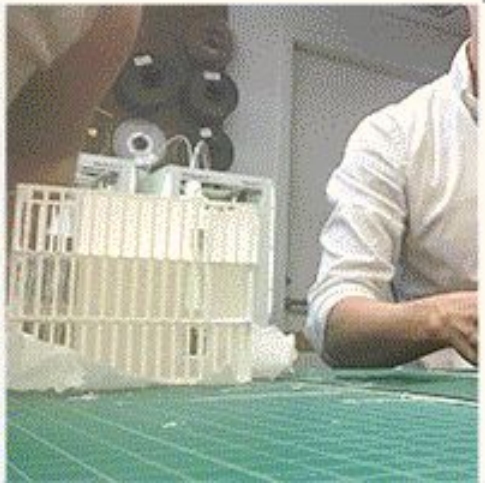


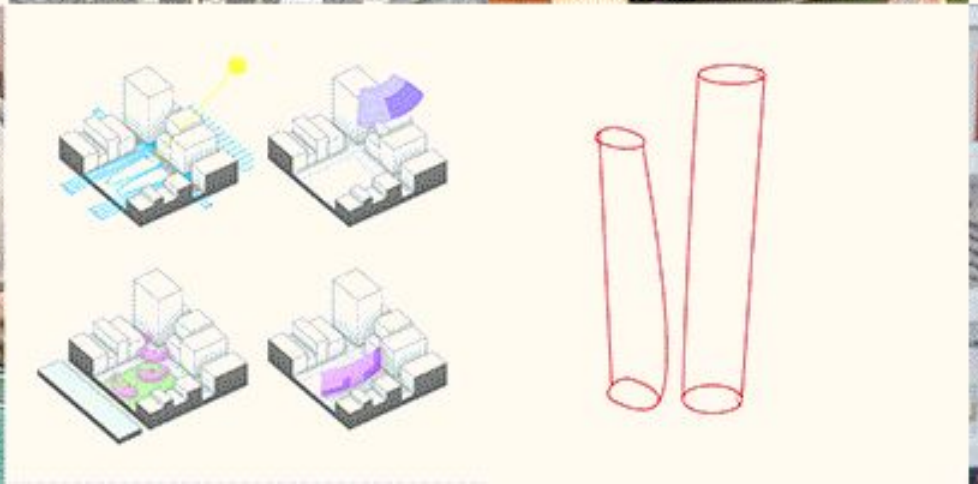




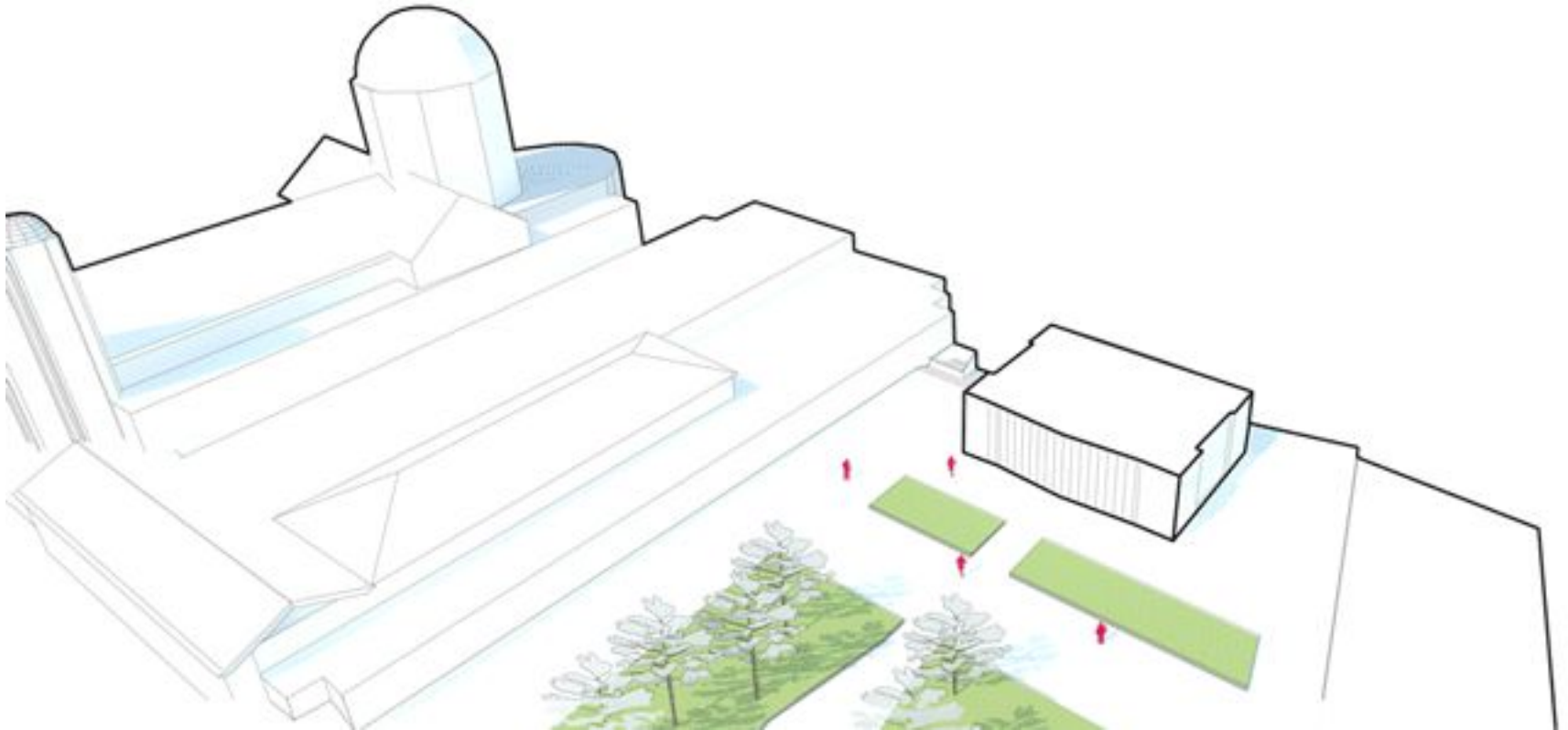


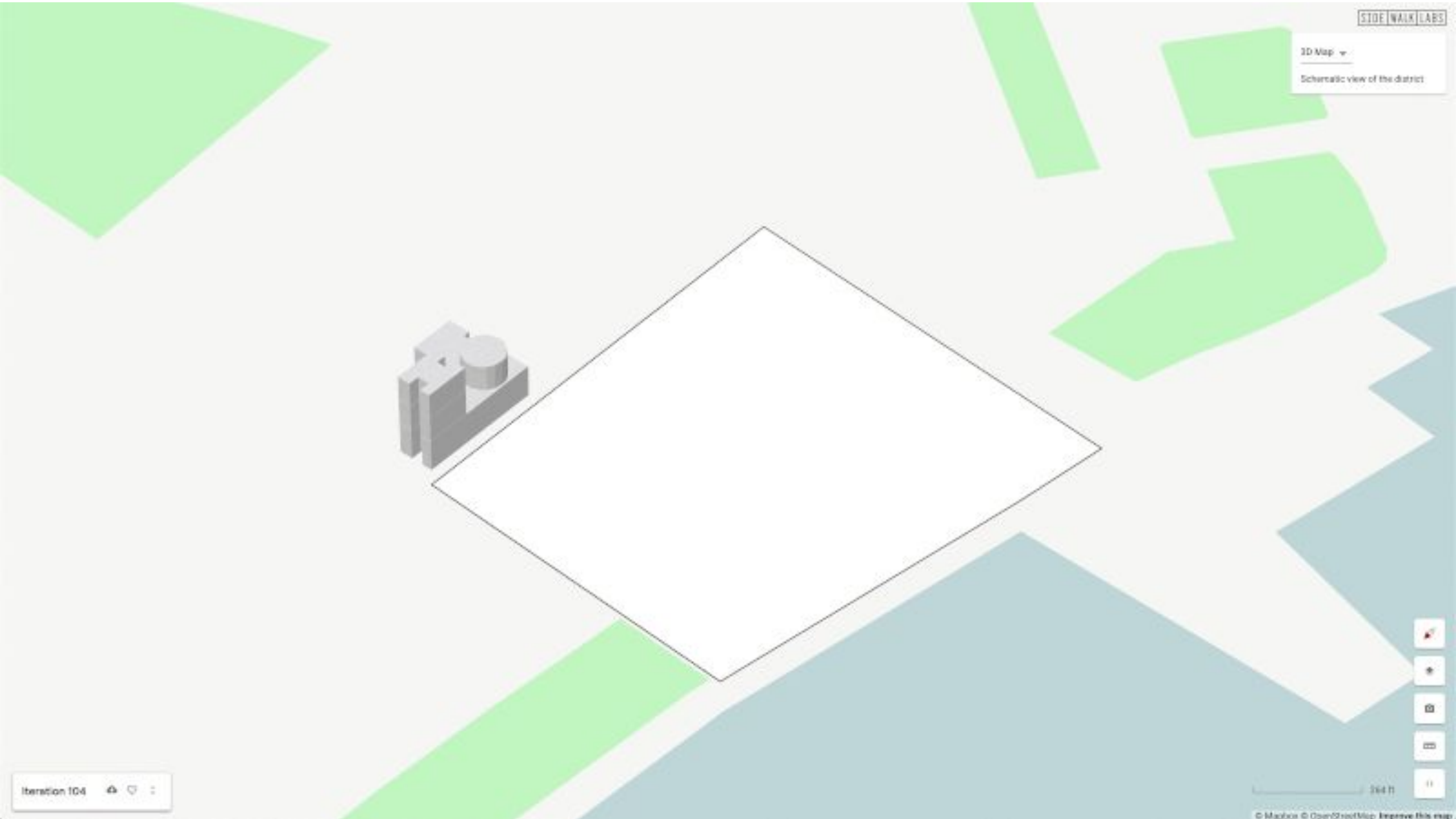


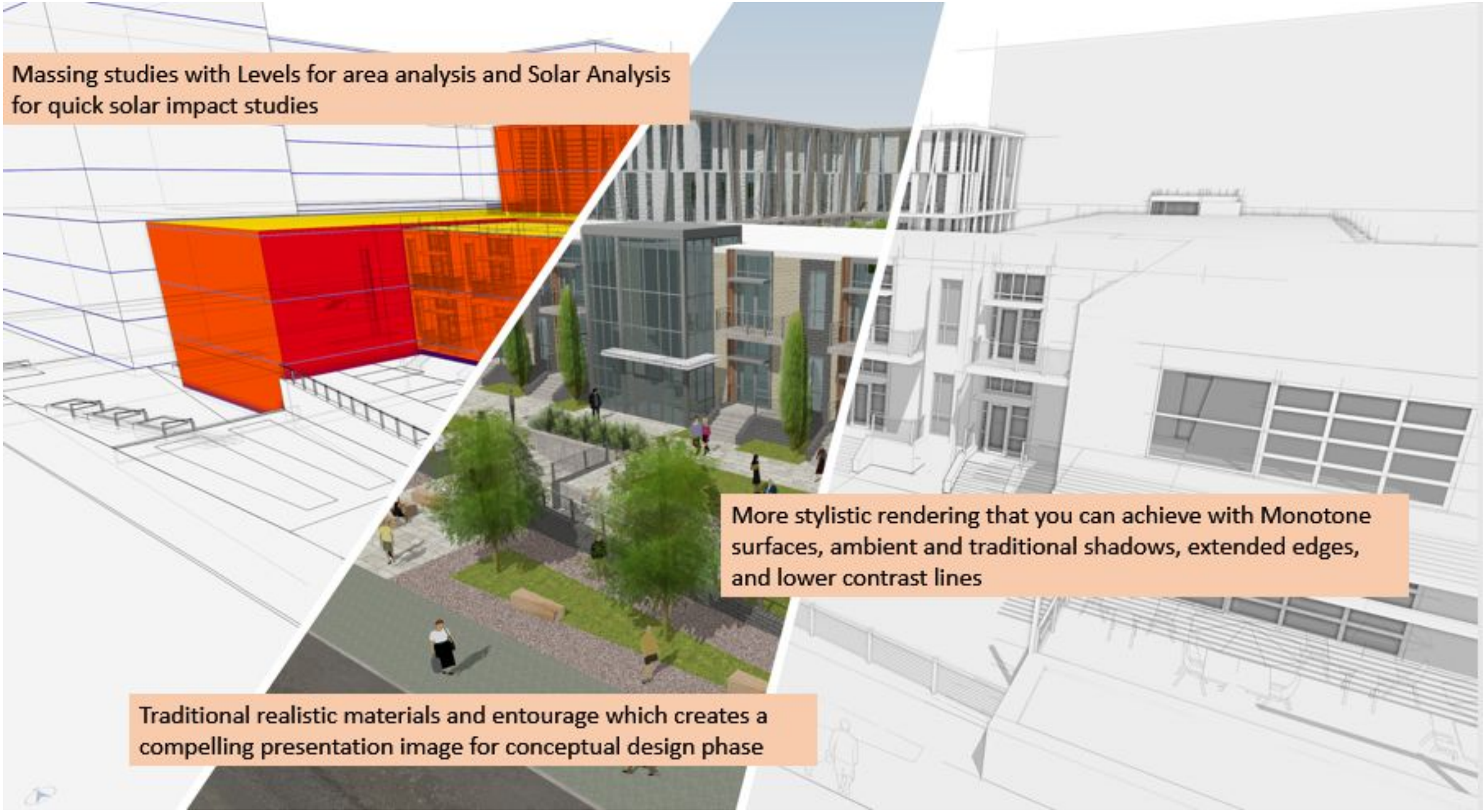




BIM Model




SIDEWALK LABS
3D Map
Schematic view of the district
Iteration 104
264 ft


Massing studies with Levels for area analysis and Solar Analysis for quick solar impact studies
More stylistic rendering that you can achieve with Monotone surfaces, ambient and traditional shadows, extended edges, and lower contrast lines
Traditional realistic materials and entourage which creates a compelling presentation image for conceptual design phase

Building Cost

Design	Build	Operate	Dispose	Total
3%	17%	Run/Maintain 40%	?%	100% Cost of Ownership
		Repair 30%		
		Periodic Replacement/ Refurbishment 10%		
1Year	2 Years	25 Years	1 Year	Total

Ref. Tumer and Townsend, Construction and Management Consultants

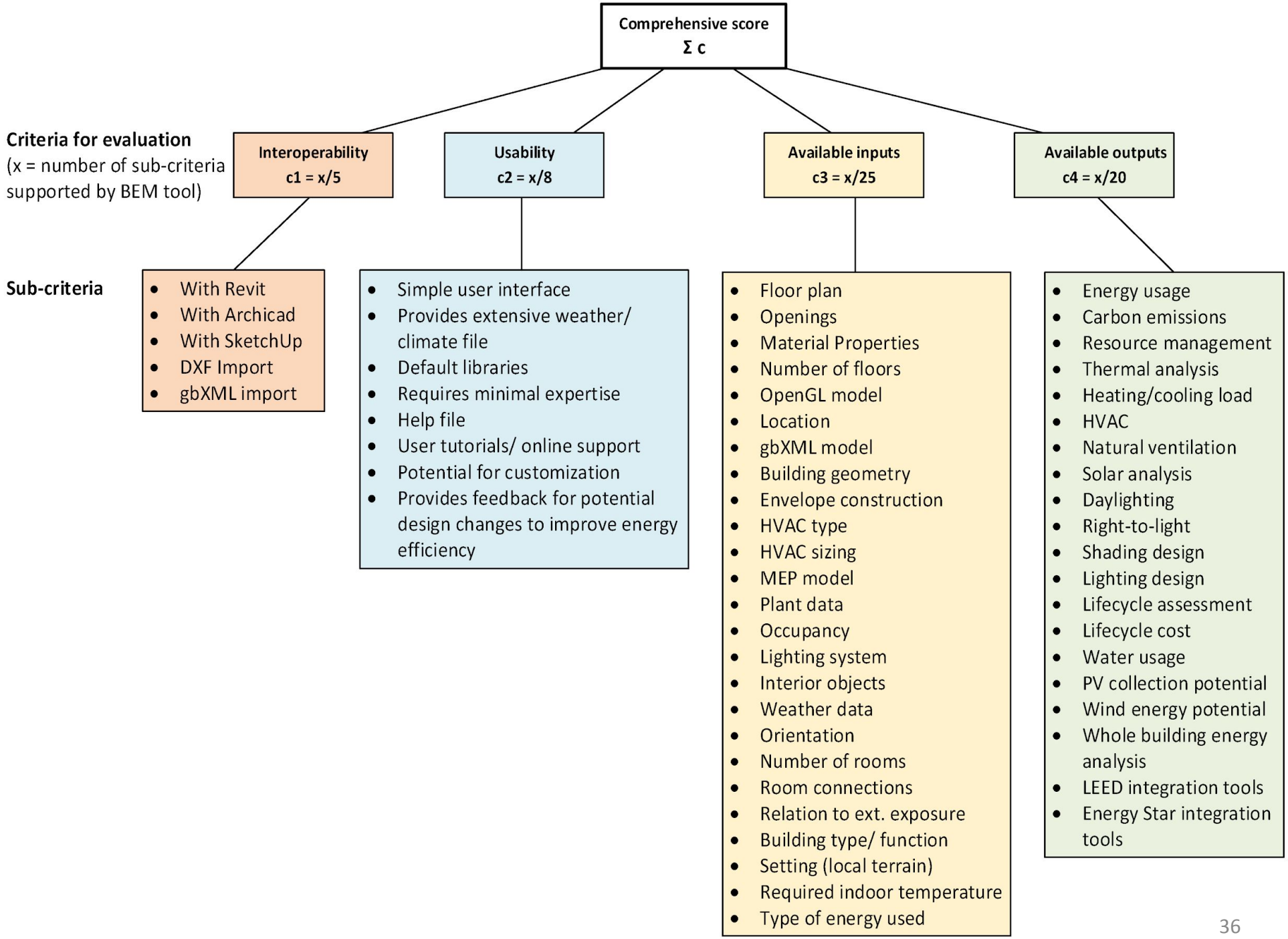
Why BIM ,,Benefits of BIM,,

The color of BIM is green.

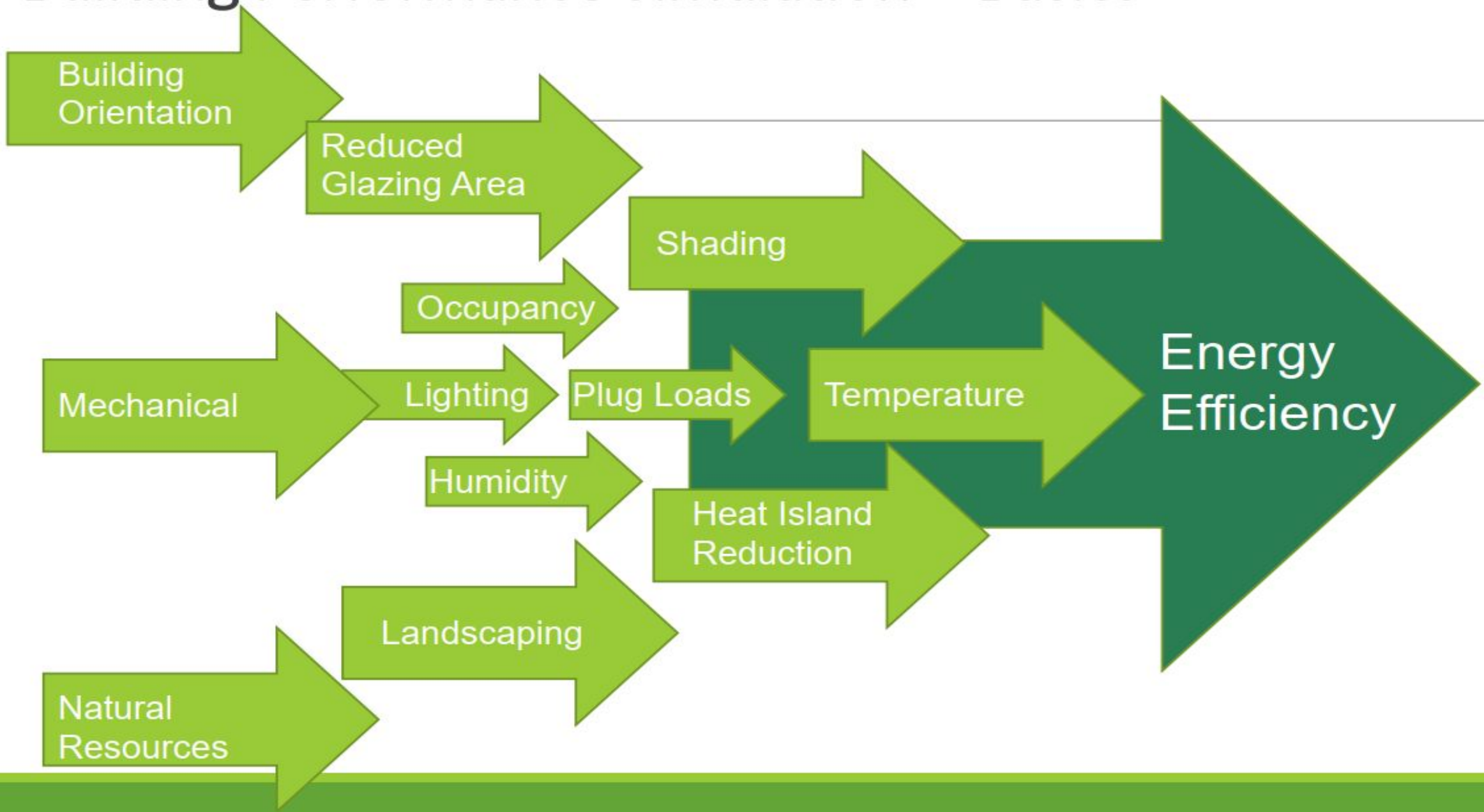
Sustainability can be defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.

“Sustainability begins with really understanding **how you will use a building.**

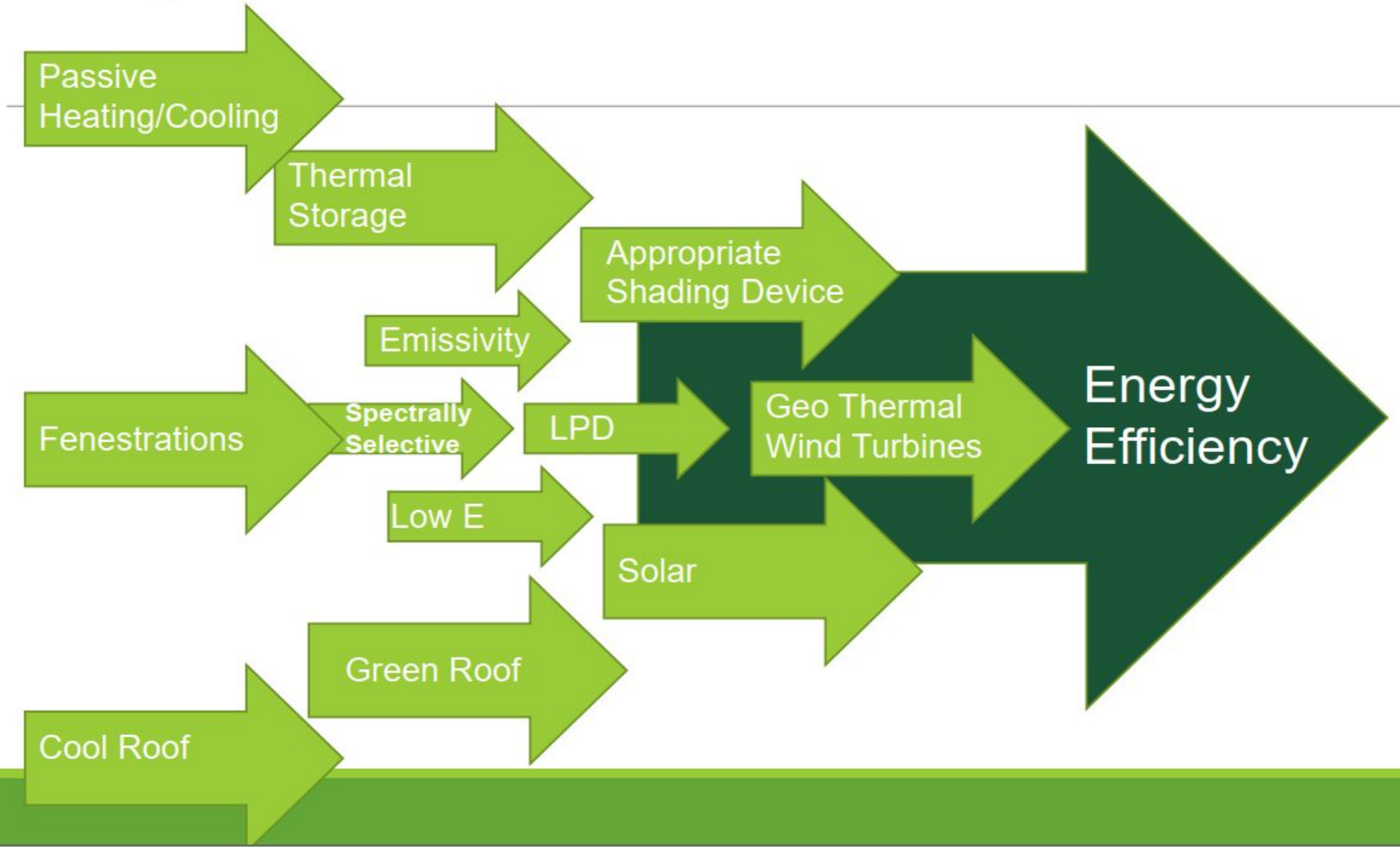
BIM lets you model the space and run analytics so you can make sure the building will efficiently support the people who use it.”


Comprehensive score
Σ c
Criteria for evaluation
(x = number of sub-criteria supported by BEM tool)
Interoperability
c1 = x/5
Usability
c2 = x/8
Available inputs
c3 = x/25
Available outputs
c4 = x/20
Sub-criteria
With Revit
With Archicad
With SketchUp
DXF Import
gbXML import
Simple user interface
Provides extensive weather/ climate file
Default libraries
Requires minimal expertise
Help file
User tutorials/ online support
Potential for customization
Provides feedback for potential design changes to improve energy efficiency
Floor plan
Openings
Material Properties
Number of floors
OpenGL model
Location
gbXML model
Building geometry
Envelope construction
HVAC type
HVAC sizing
MEP model
Plant data
Occupancy
Lighting system
Interior objects
Weather data
Orientation
Number of rooms
Room connections
Relation to ext. exposure
Building type/ function
Setting (local terrain)
Required indoor temperature
Type of energy used
Energy usage
Carbon emissions
Resource management
Thermal analysis
Heating/cooling load
HVAC
Natural ventilation
Solar analysis
Daylighting
Right-to-light
Shading design
Lighting design
Lifecycle assessment
Lifecycle cost
Water usage
PV collection potential
Wind energy potential
Whole building energy analysis
LEED integration tools
Energy Star integration tools

Building Performance Simulation – Basics



Building Performance Simulation – Advanced



Weather Data

Design Conditions

– ASHRAE Handbook of Fundamentals

• Weather Statistics & Observations

– National Climatic Data Center (U.S.)

– Mesowest (Southwest U.S.)

– Weather Bank (International)

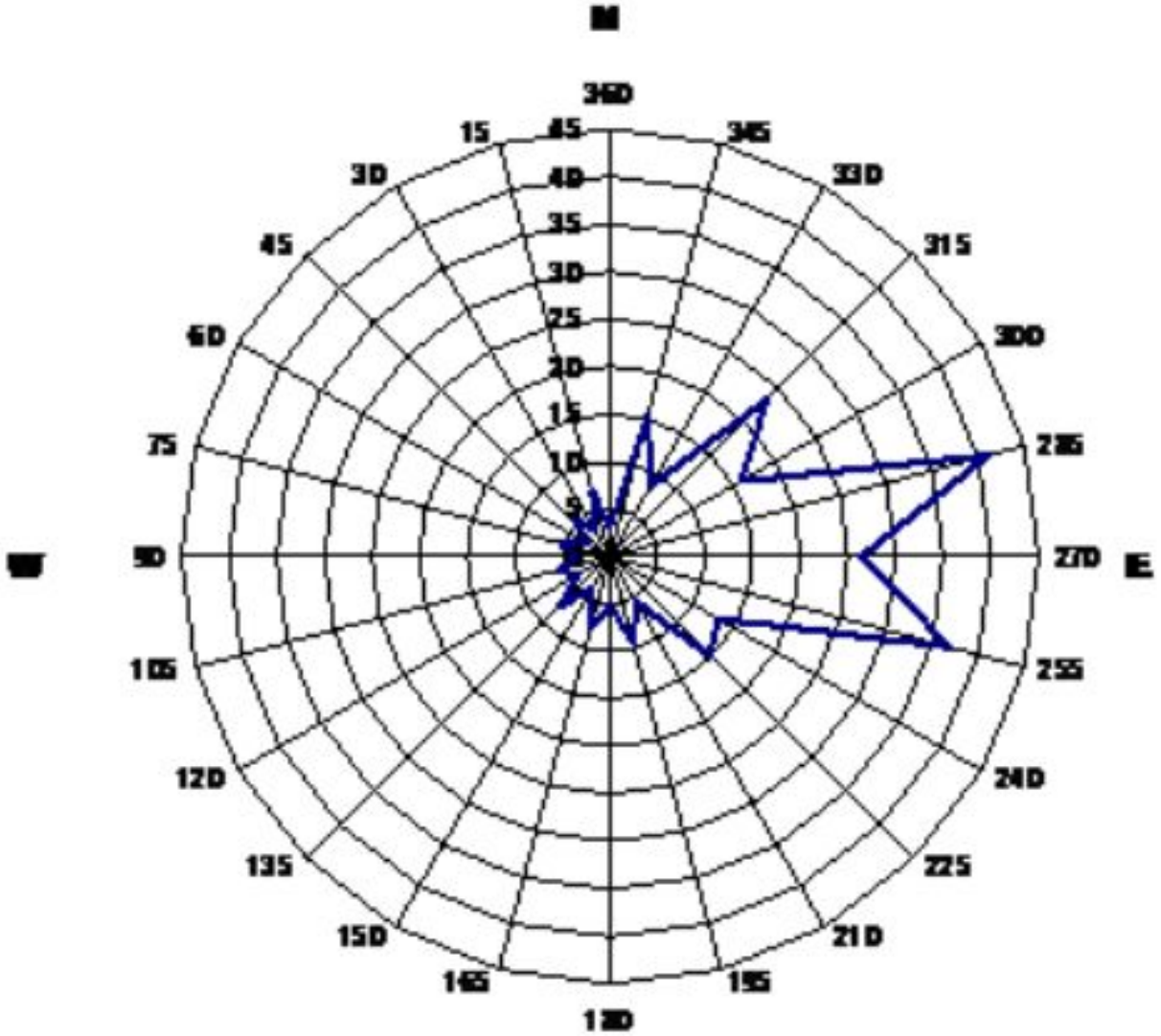
• Annual Weather Data

– DOE-2 Website (TMY, WYEC, etc)

– EnergyPlus Website (EPW, CSV)

• International Weather Data

– EnergyPlus Weather Source Data

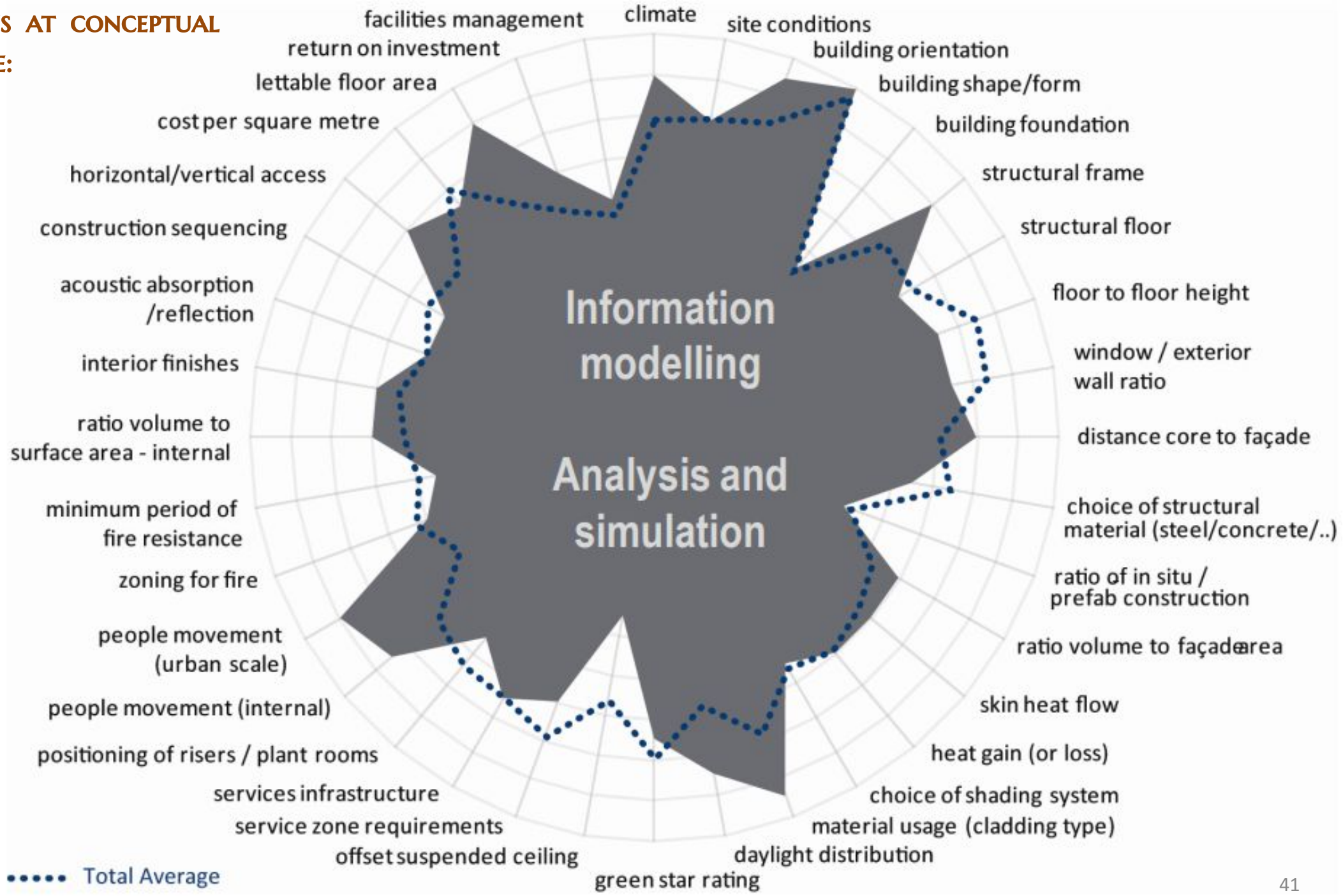


Weather Data

A weather data layer for Google Earth on the US EERE weather file site shows EnergyPlus weather file locations. This allows a designer to compare nearby weather files for the best site match, accounting for any change in elevation, proximity to mountains or water bodies, as shown in Case Study 5.3. Google Earth images use data from SIO, NOAA, the U.S. Navy, NGA, GEBCO, Cnes Spot Image, Terrametrics, and IBCAO

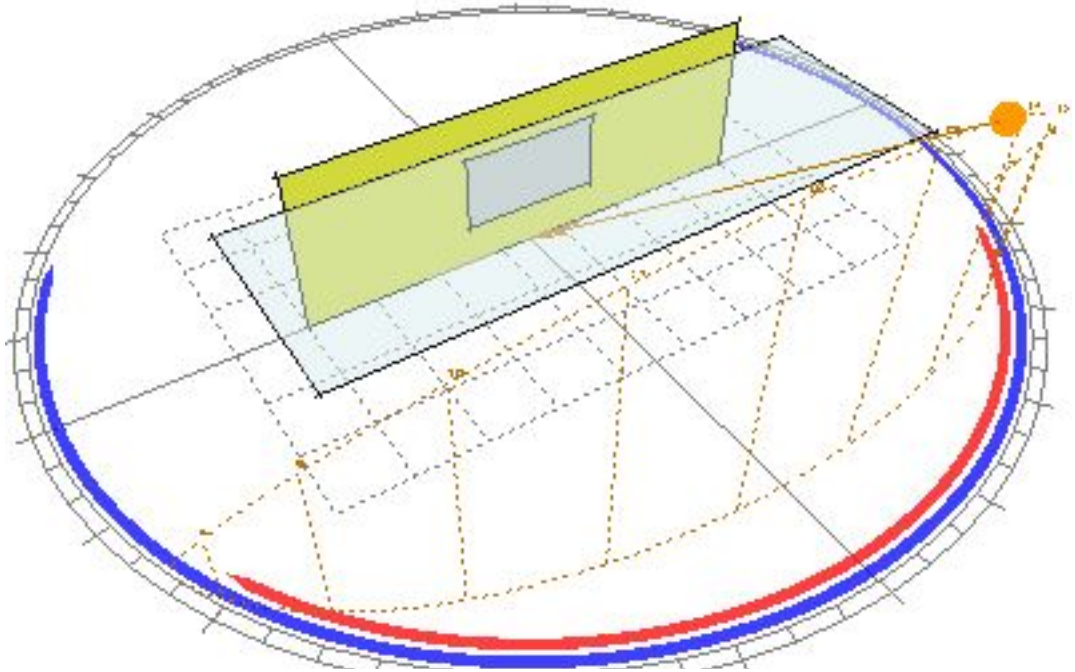
Basic energy studies at conceptual design stage include:

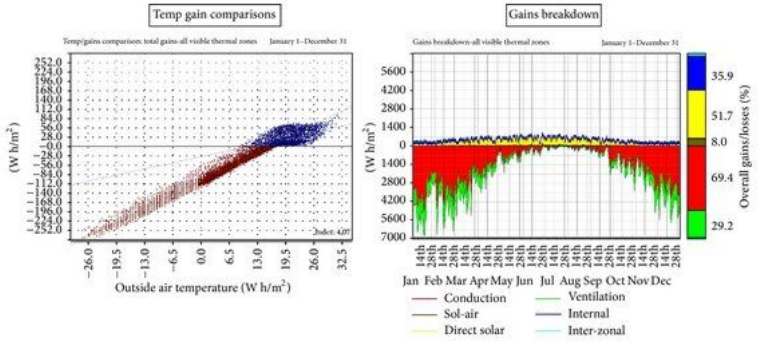
-

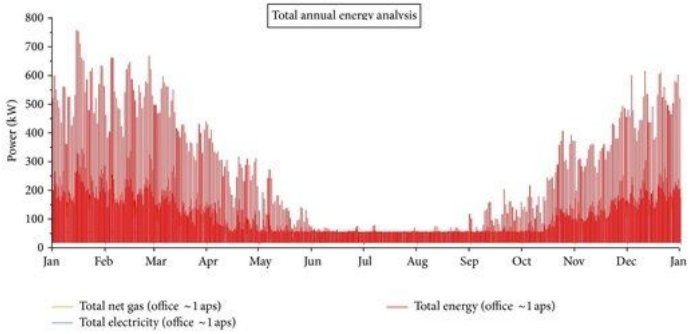


BASIC ENERGY STUDIES AT CONCEPTUAL DESIGN STAGE INCLUDE:

- Sun and shadow
  - Wind / natural ventilation
  - Solar loads / radiation
  - Building envelope performance
  - Heating & Cooling loads
  - Daylight availability
  - Whole building energy use & costs
  - Water use & costs (indoor, outdoor)
  - Carbon emissions
    - Lighting analysis
    - CFD analysis
    - Fire analysis
    - Solar/shading analysis
    - Energy code compliance
    - Thermal comfort
    - Heating and cooling load analysis
    - LCA Life Cycle Assessment
    - Renewable energy
    - HVAC equipment sizing

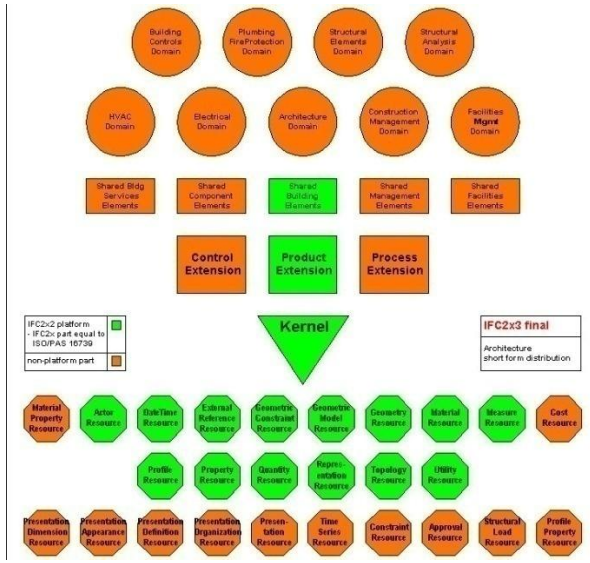






Sustainable Design Simulations Run on Information Models and Databases

XML and IFCs have emerged as sustainable design information modeling standards.



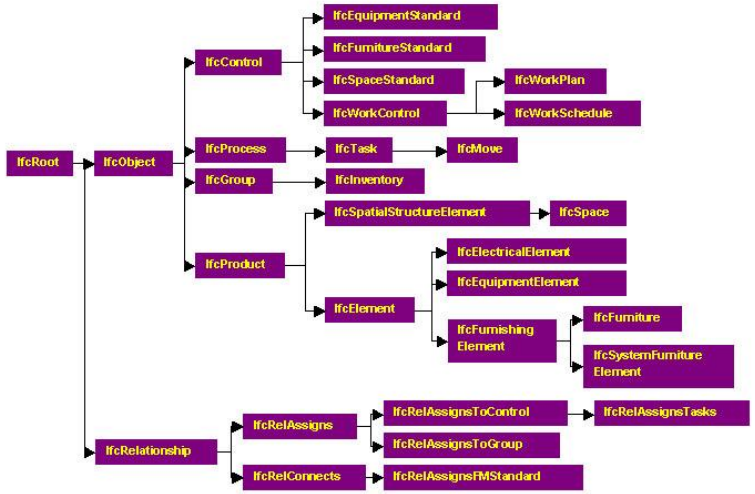


Figure 10: Tracing inheritance structure to IfcRoot

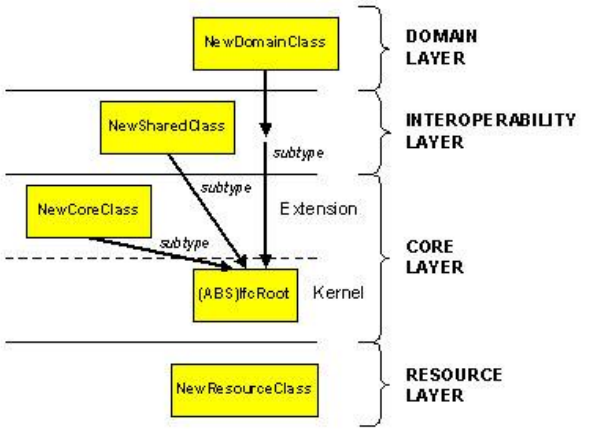
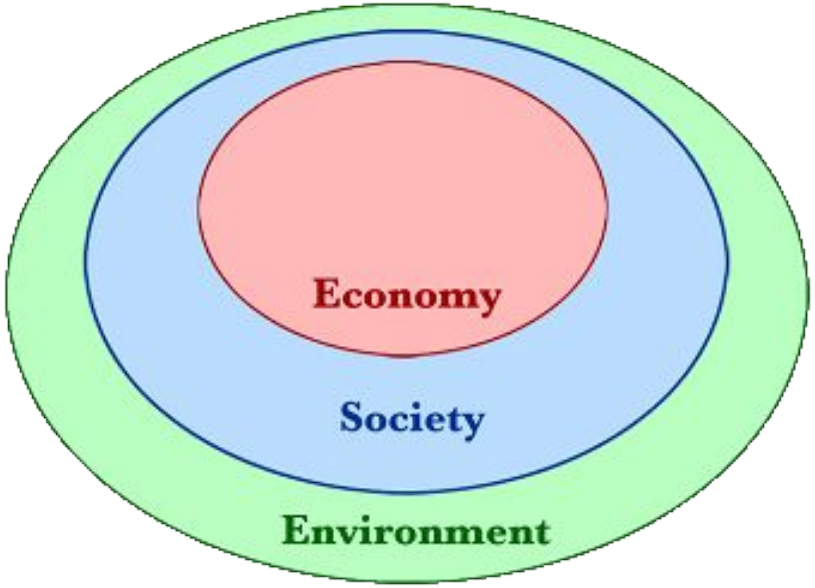
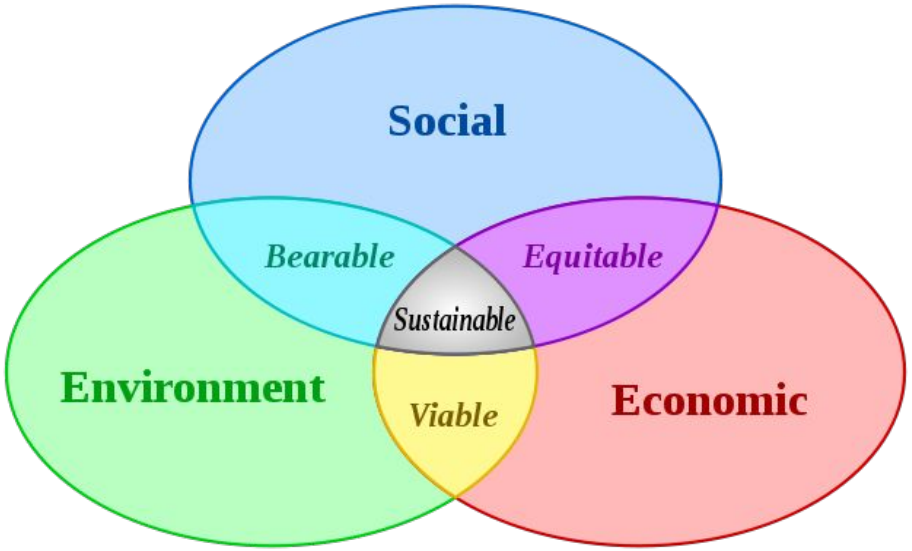


Figure 13: IfcRoot as the common supertype

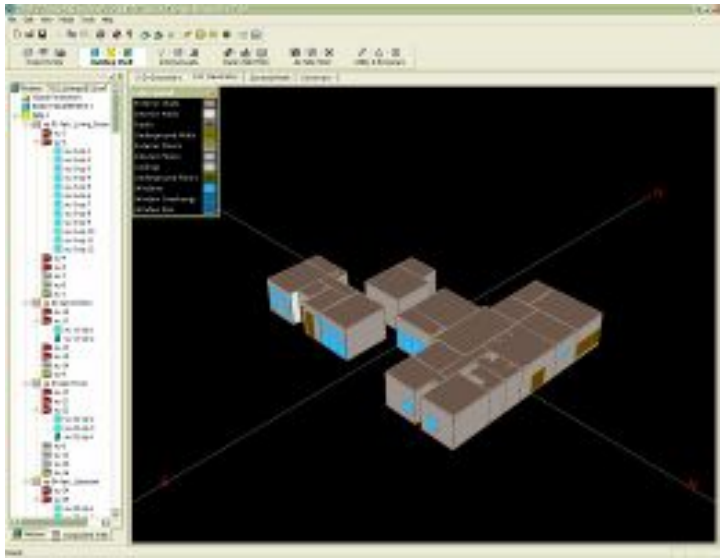
Sustainability: Graphical Models



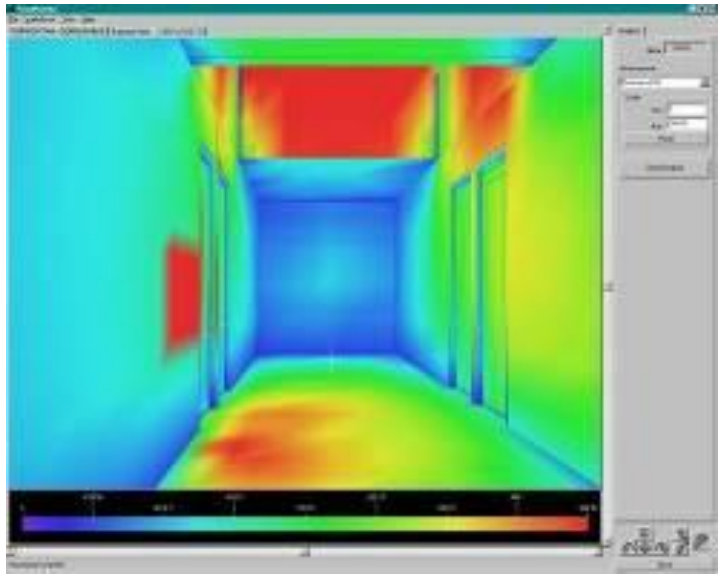


http://creativecommons.org/licenses/by/2.0/

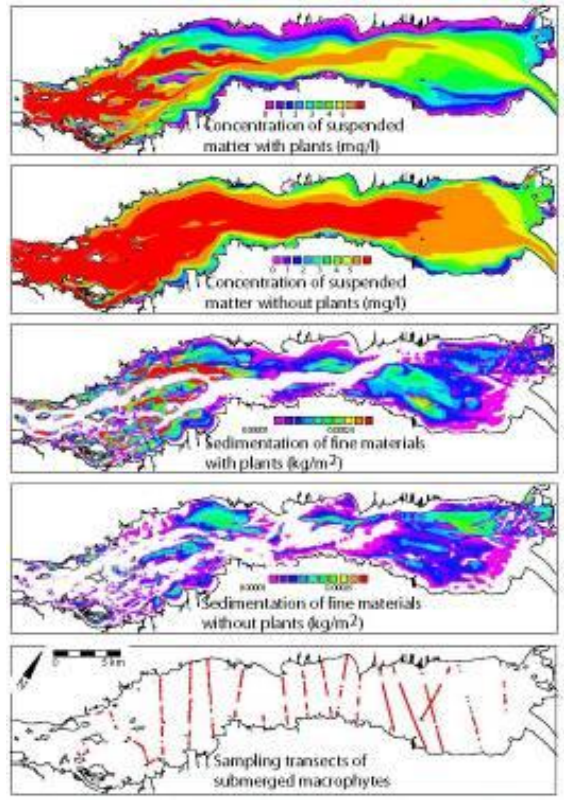
Information Models Enable Sustainable Design Simulations



Educational Campus Building Energy Use Simulation



Educational Campus Building Daylighting Simulation



Lake Ecology Simulation

What are the main sustainability challenges that society faces today?

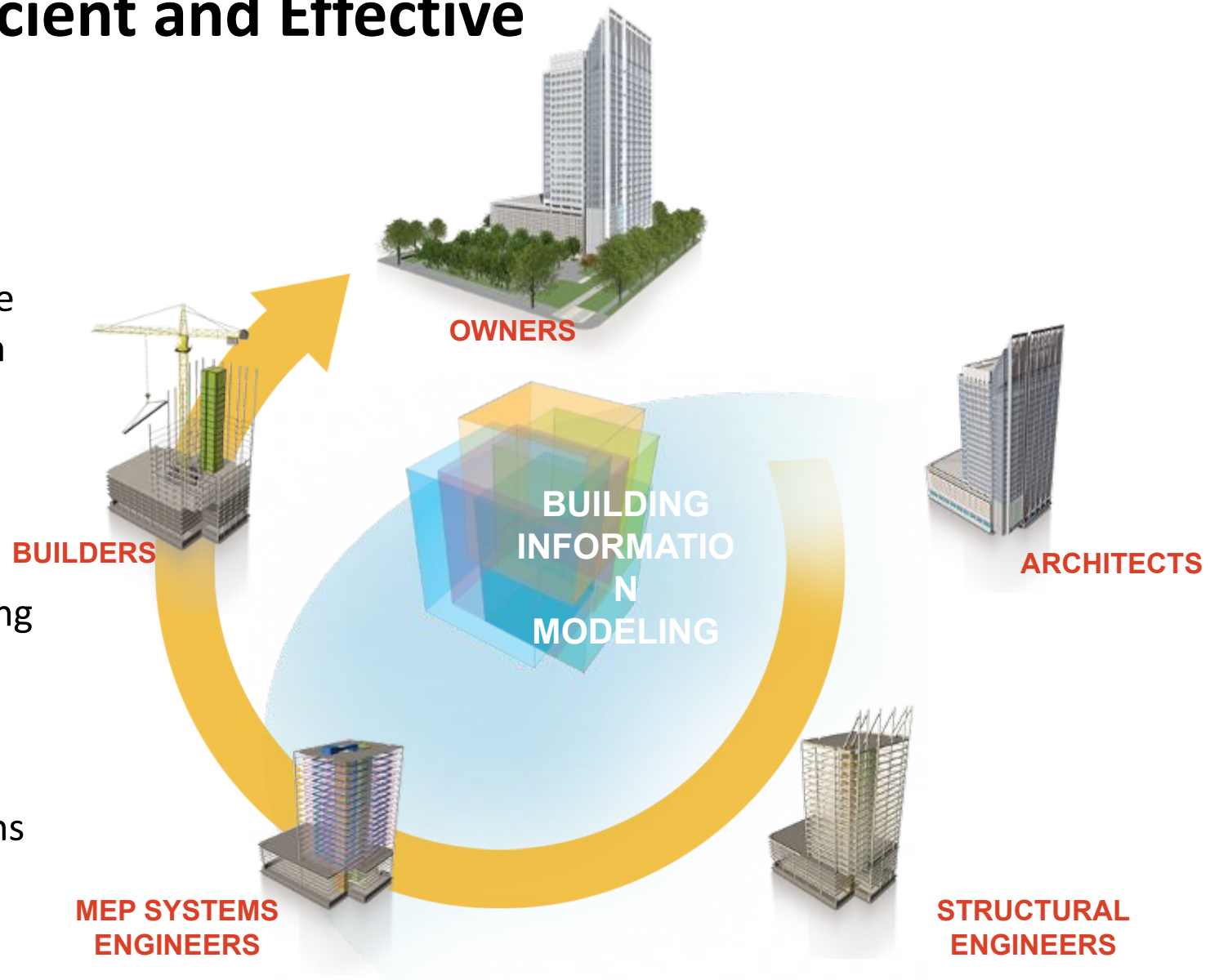
- Mitigating Global Warming and Associated Climate Change While Meeting the Increasing Needs for Energy

Reversing the Loss of Biodiversity

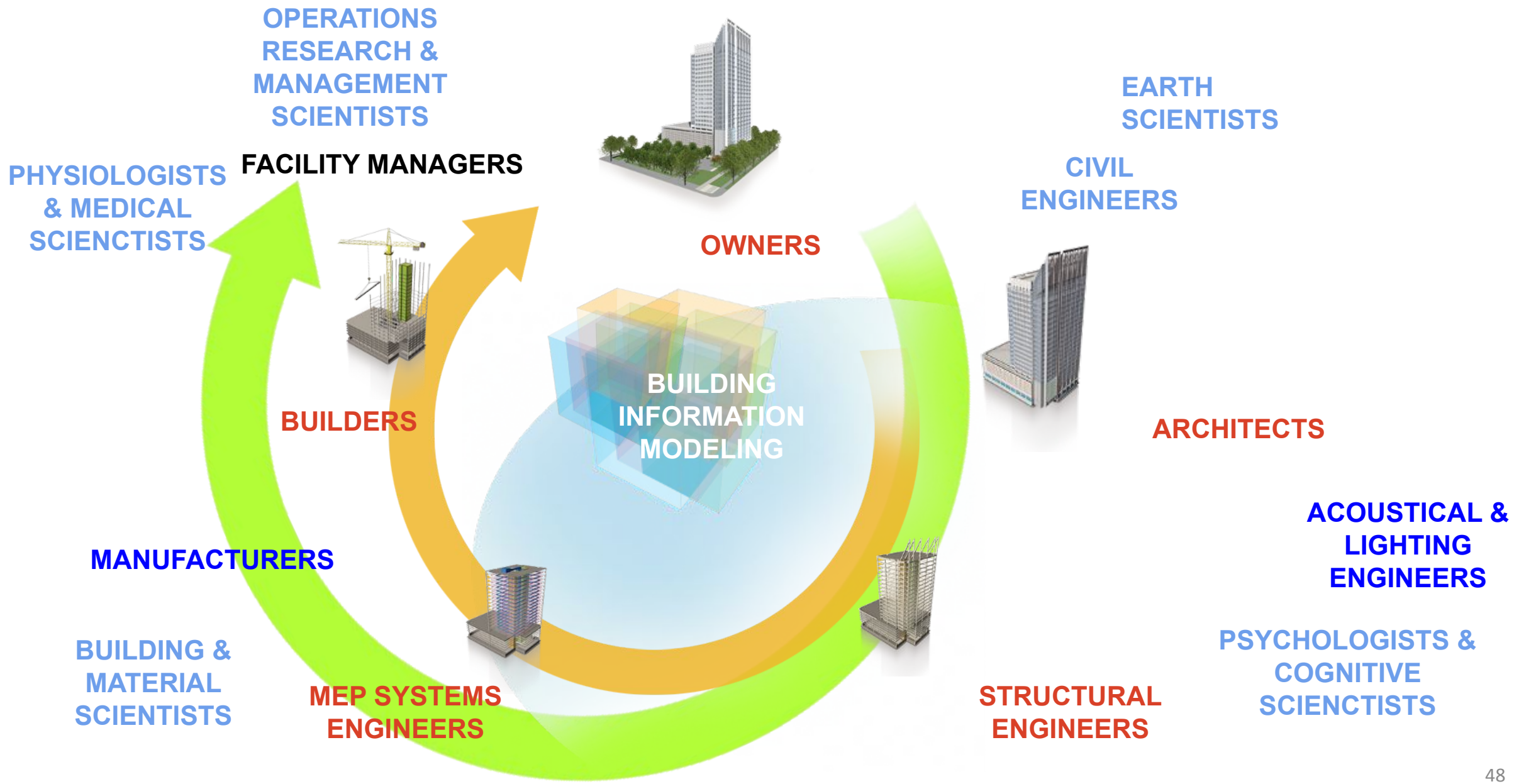
- Maintaining and Improving Access to Fresh Water
- Maintaining and Improving Access to Healthy and Affordable Food through Sustainable Agriculture
- Maintaining and Expanding Critical Infrastructure that Mitigates Environmental Impacts on Human Health and Improves the Quality of Human Life

BIM is a Catalyst for Efficient and Effective Sustainable Design

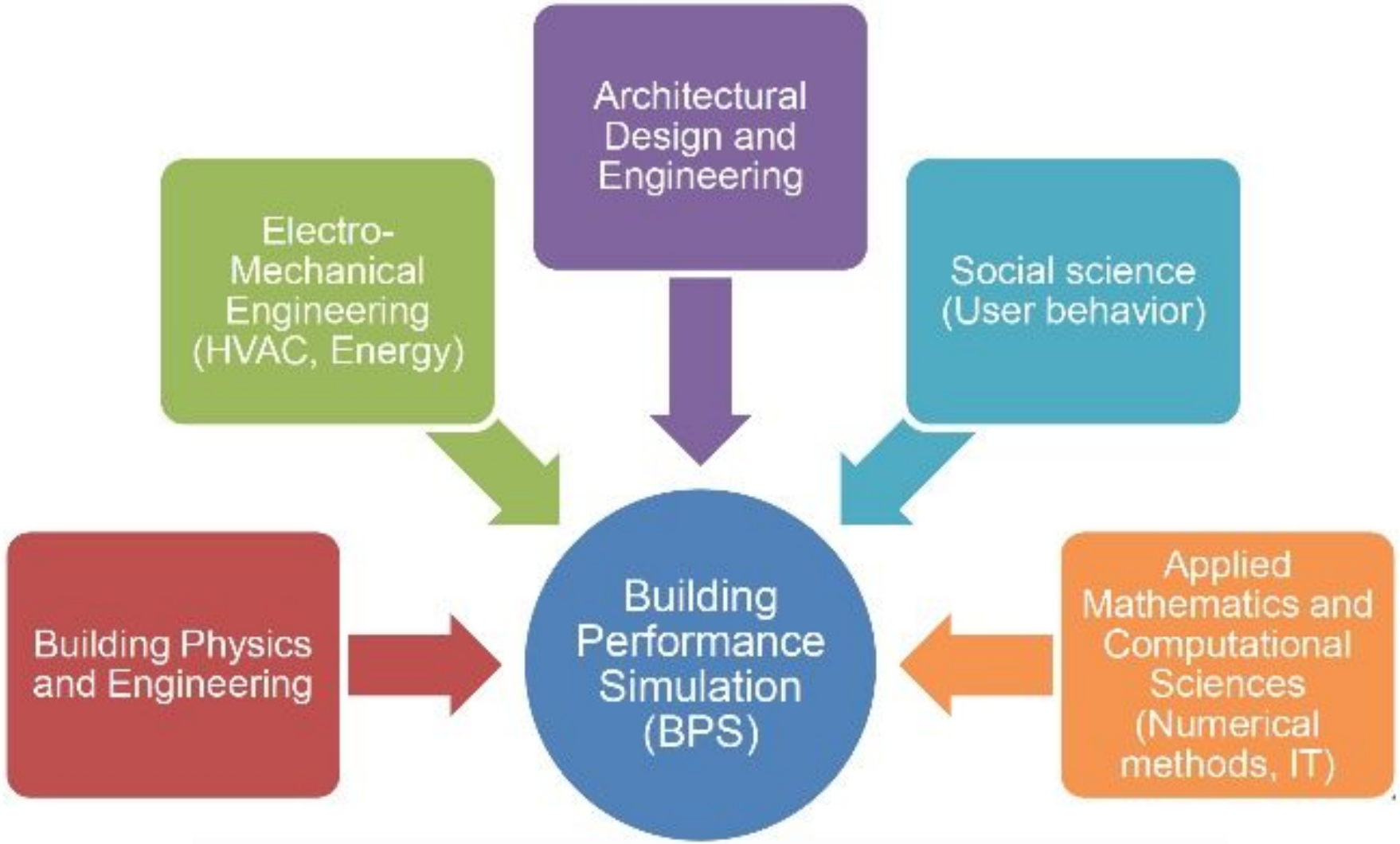
- The most advanced design technology available.
- Makes information available for analysis earlier in design process.
- Supports an improved collaborative process.
- Reduces the effort of increasingly complex building design.
- Facilitates a holistic design approach.
- Enables accurate simulations of building design performance.



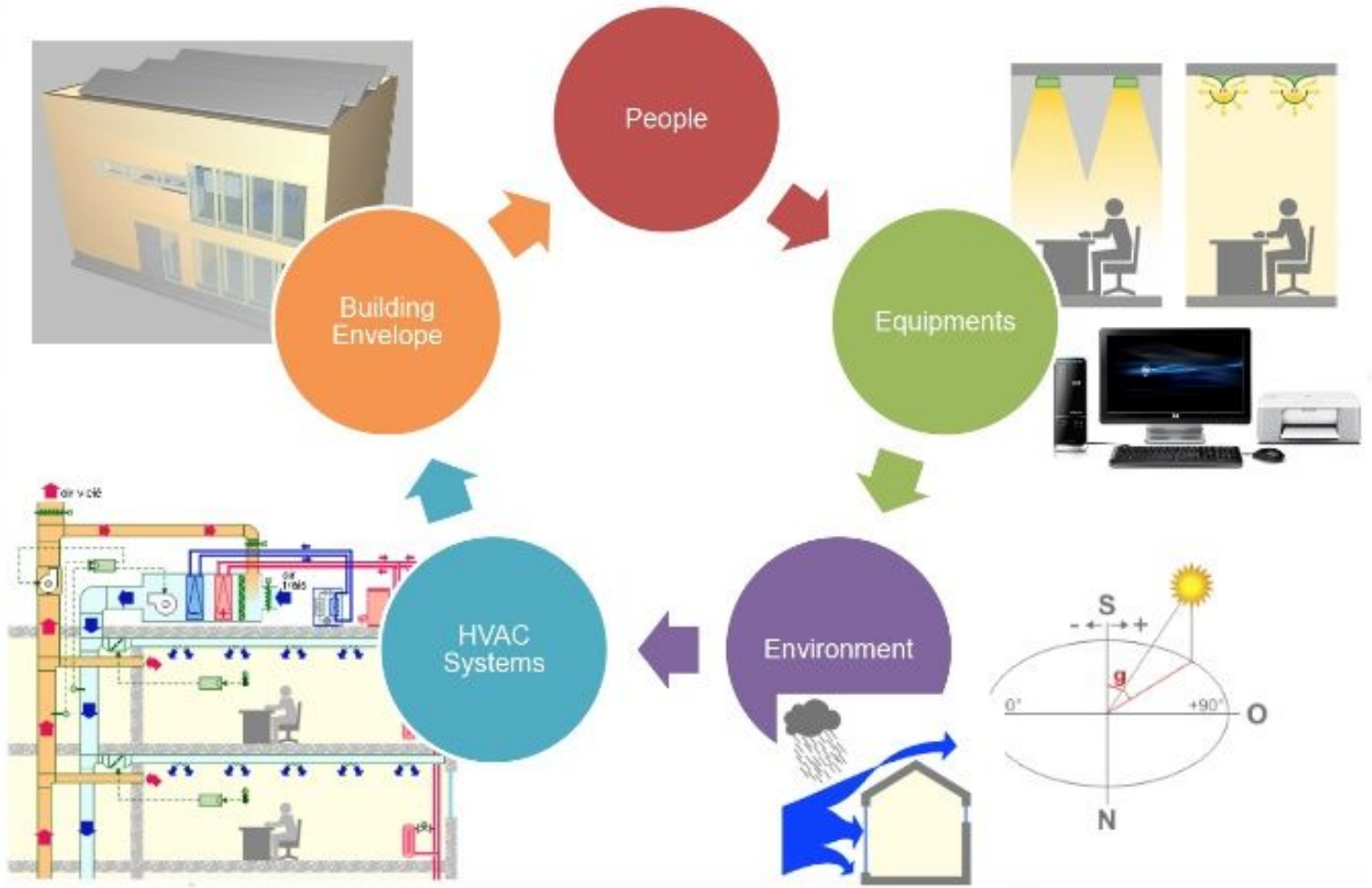
BIM Is a Catalyst for Collaborative Sustainable Design



BPS discipline is multi-disciplinary

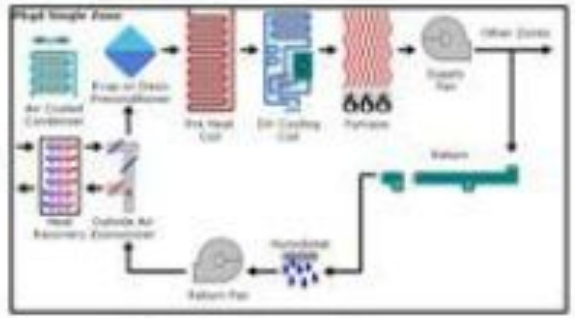


BPS simulates complex coupled systems



Building geometry

Weather conditions



HVAC systems

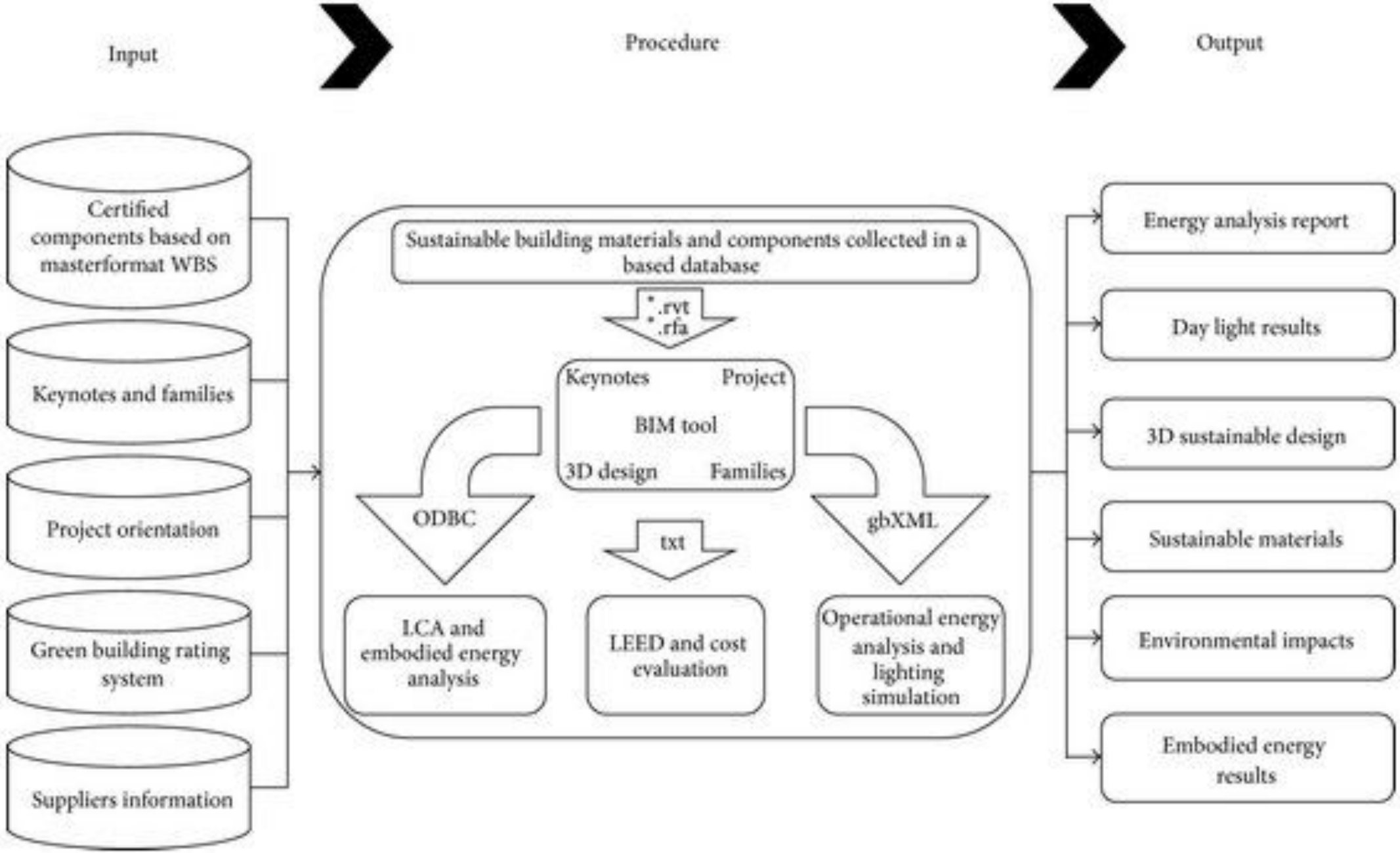
Internal loads

Operating strategies and schedules

Simulation engine

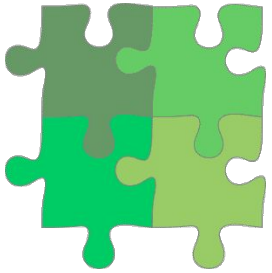
Simulation specific parameters

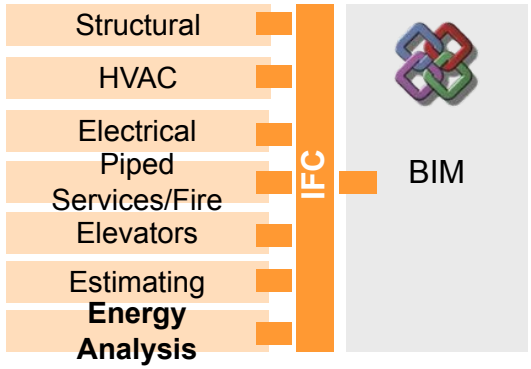
Results

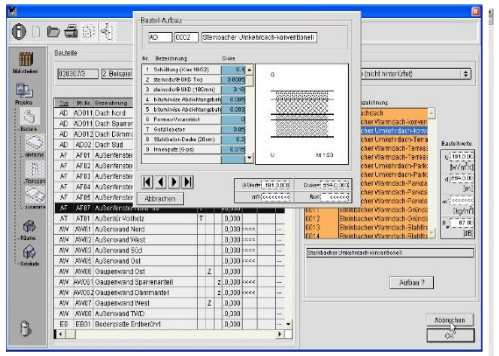

Input
Procedure
Output
Certified components based on masterformat WBS
Keynotes and families
Project orientation
Green building rating system
Suppliers information
Sustainable building materials and components collected in a based database
*.rvt
*.rfa
Keynotes
Project
BIM tool
3D design
Families
ODBC
txt
gbXML
LCA and embodied energy analysis
LEED and cost evaluation
Operational energy analysis and lighting simulation
Energy analysis report
Day light results
3D sustainable design
Sustainable materials
Environmental impacts
Embodied energy results

BIM as Collaborative Foundation

- Intelligent building model
- IFC (INDUSTRY FOUNDATION CLASS)- Seamless sharing and exchange of 3D model's information for generating building simulations
- Strategic partnership and cooperation with analysis software vendors







BIM

- Structural Engineering
- Collision Detection
- Code Checking
- Building Performance and energy simulations

What is a model?

A model is a representation of something else.

A model is useful if it is able to:

- **Explain past observations.**
- **Predict future observations.**
- **Help control future events.**
- **Deliver value at a relatively low cost especially in combination with other models.**
- **Be easily proven to be false or inaccurate**
- **Present simplicity or even aesthetic appeal.**

Who is the typical building simulationclient?

ARCHITECTURAL

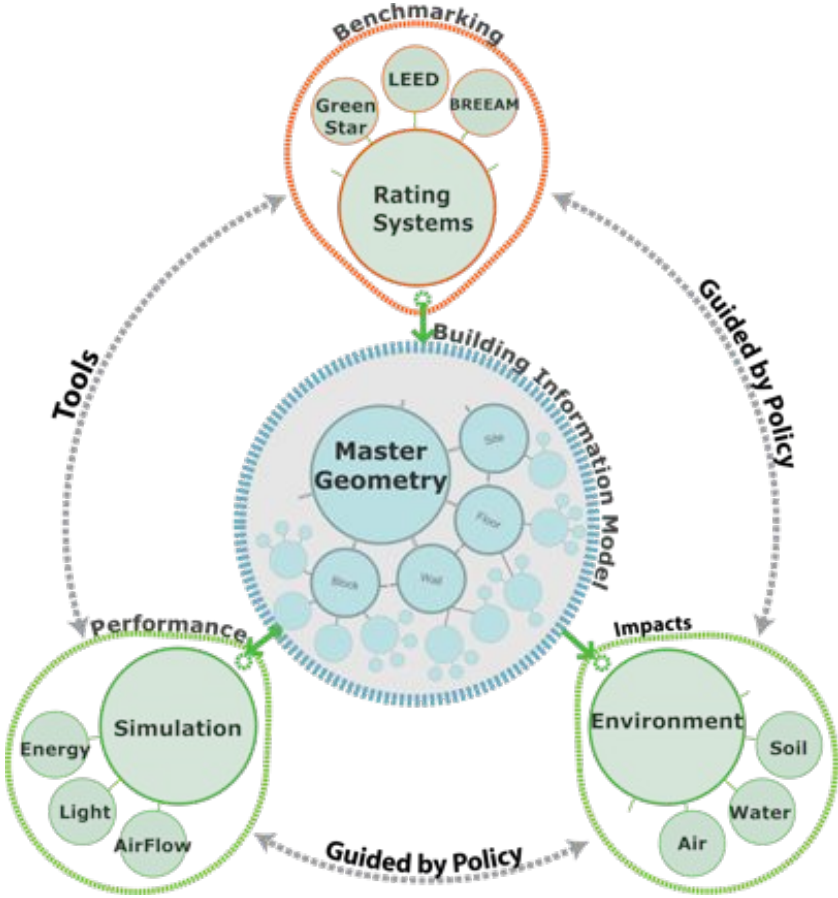
- Designers
- Architects
- Master planners
- Urban designers
- Interior Designers

ENGINEERS

- HVAC
- Mechanical
- Electrical
- Building Physics

rating systems

- Egyptian Green Building
- BREEAM
- LEED
- DGNB
- Estidama
- Gsas
- Other “green” ratingsystems



Vs

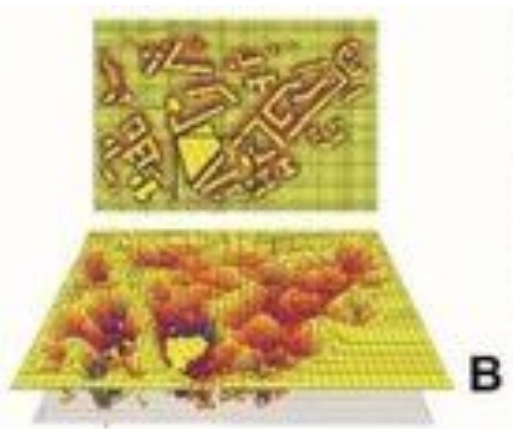
Vs

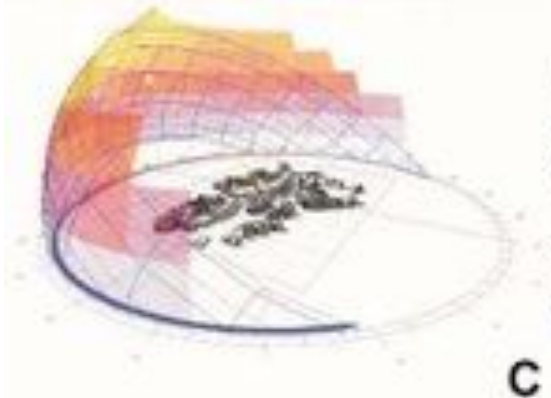
Rating systems, that are used to evaluate and benchmark sustainability, are constantly evolving

Adoption of "sustainable building rating systems offer a **roadmap** that lead to sustainability goals and help align requirements"

Results from BIM software analysis.

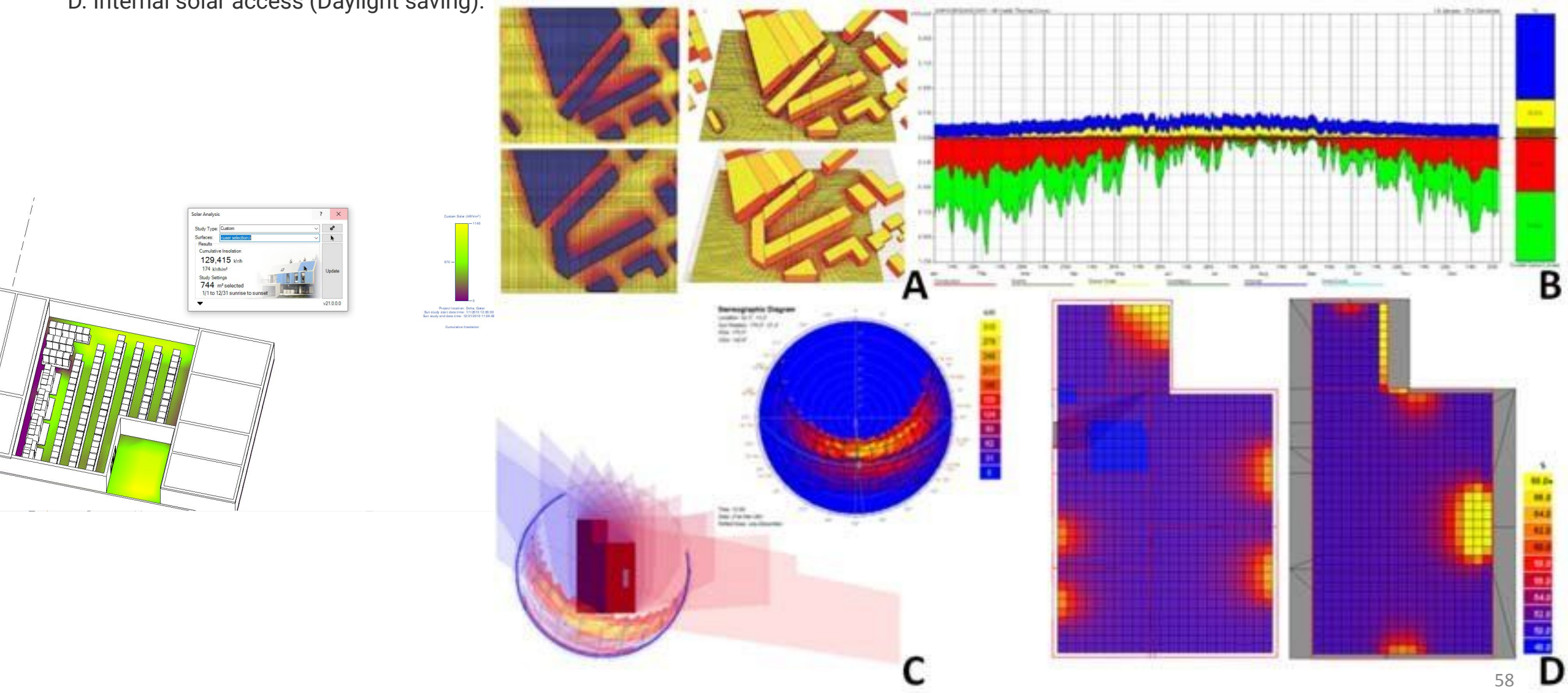
A. Physical model,
B. Model transposition to the software,
C. Sunlight analysis on surfaces determine the amount of passive energy,
D. Sound/noise analysis,
E. Analysis of the year shadow range,
F. Wind analysis,
G. Shadow analysis taking into account the annual passive energy distribution,
H. Colorful of the shadow range.



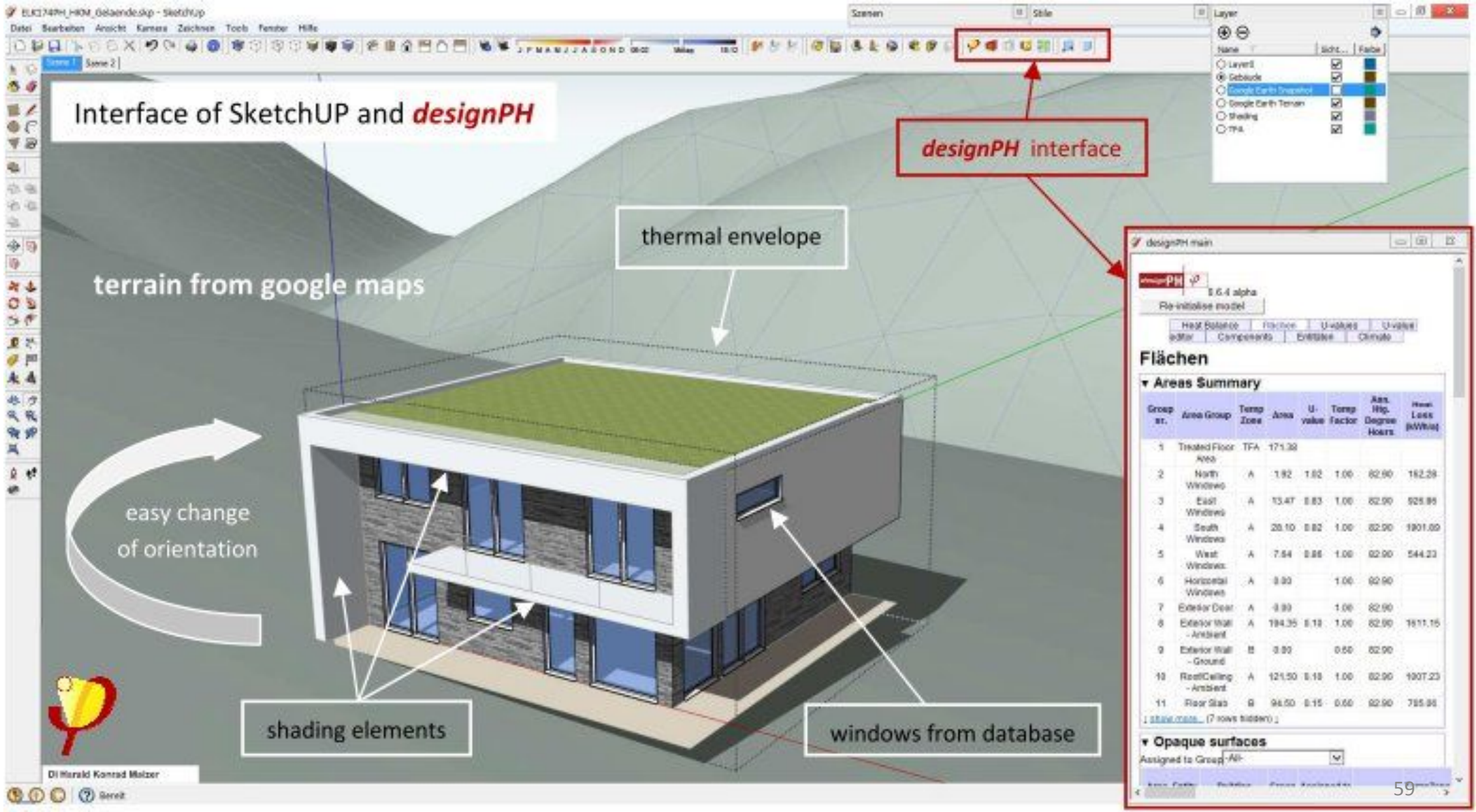


Results from BIM software analysis.

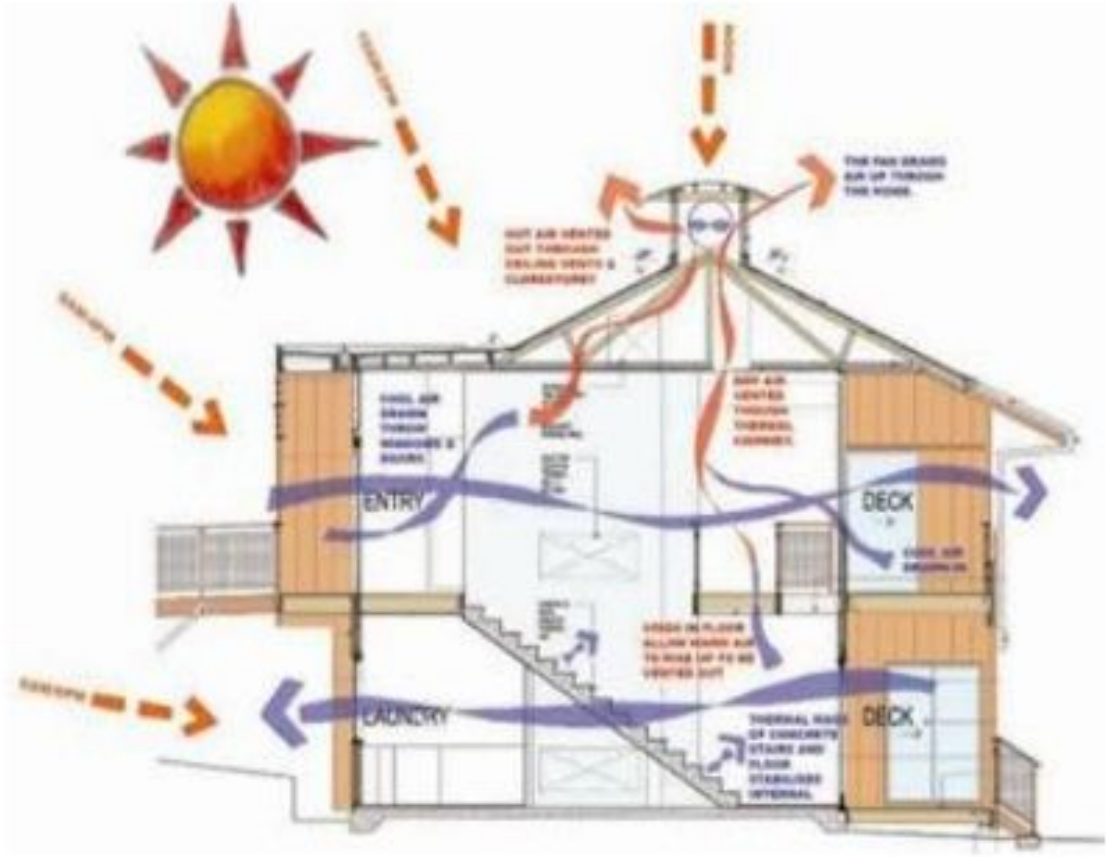
A. Shading analysis of surface sun exposure which attempts to re-design object structures;
B. Thermal analysis-passive gains;
C. Shadow range and sun exposure;
D. Internal solar access (Daylight saving).

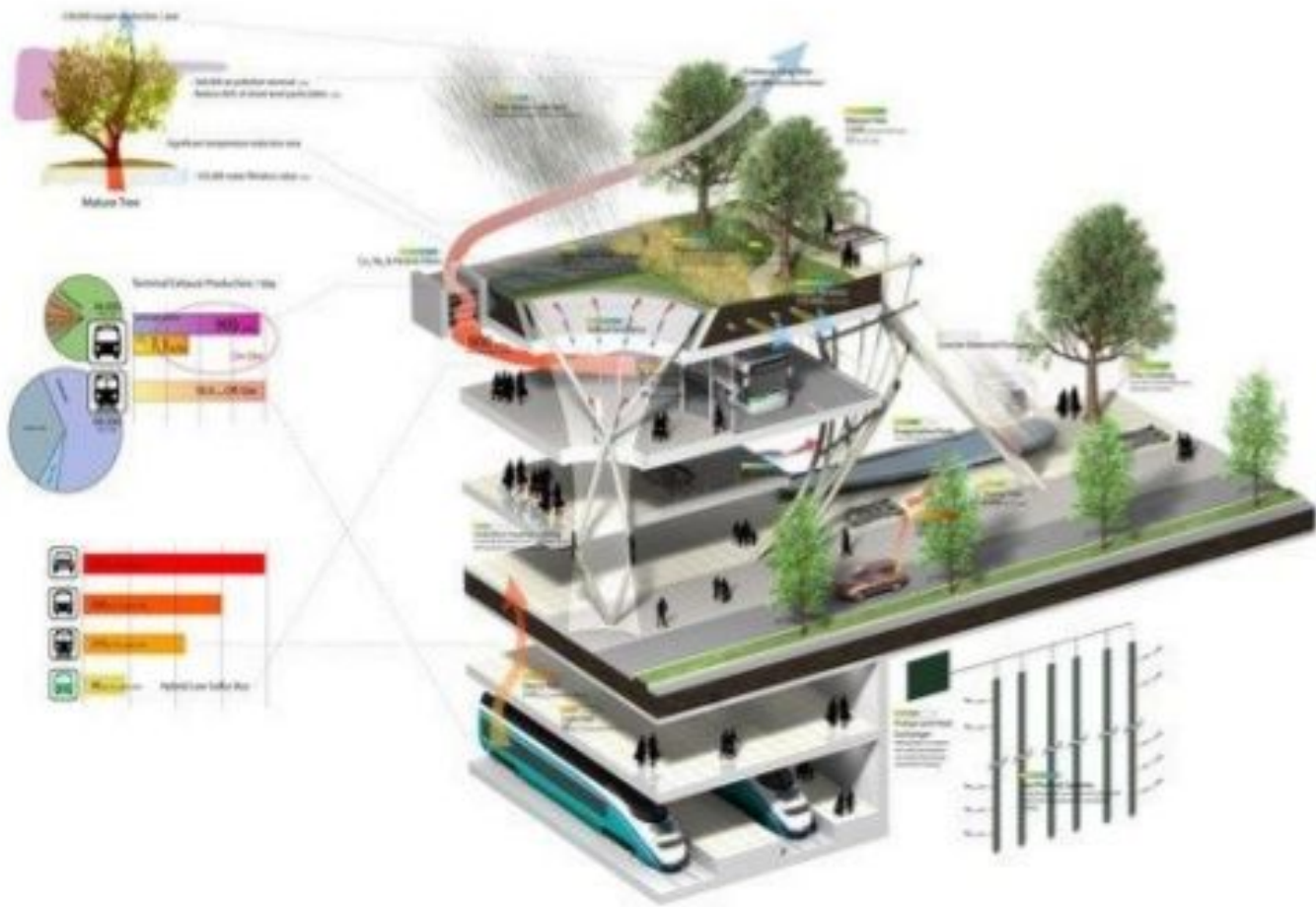


Passive Design

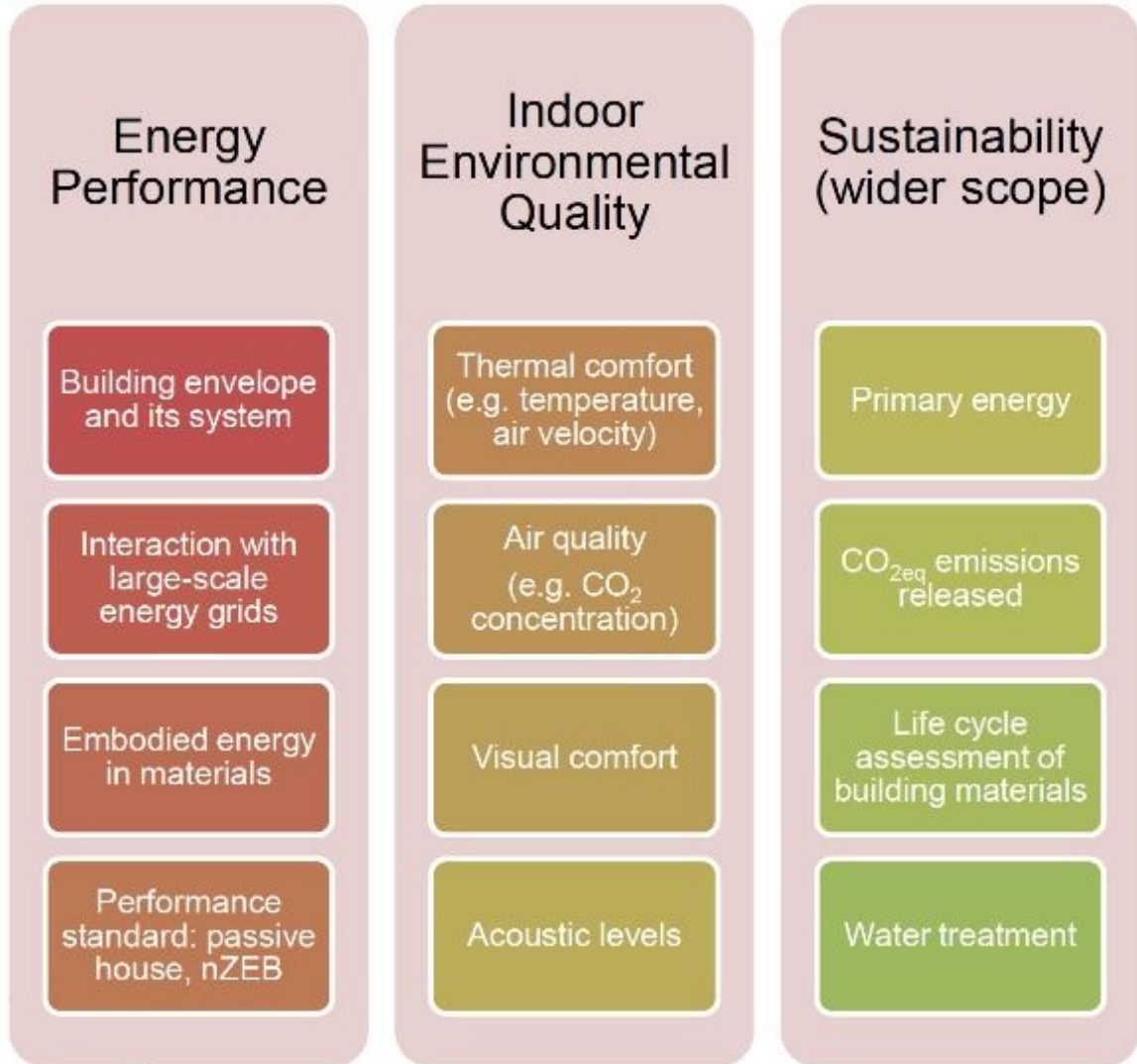


Sustainable architecture is integrating two aims include Technology and human’s aim





BPS is multi-objectives



Carbon

- Carbon footprinting with BIM helps us test conceptual designs so we can specify solutions with the lowest carbon impact. This allows us to identify low carbon options that have the potential to drive down carbon emissions during the design and construction phases, as well as options that lead to carbon savings during a building's operation.

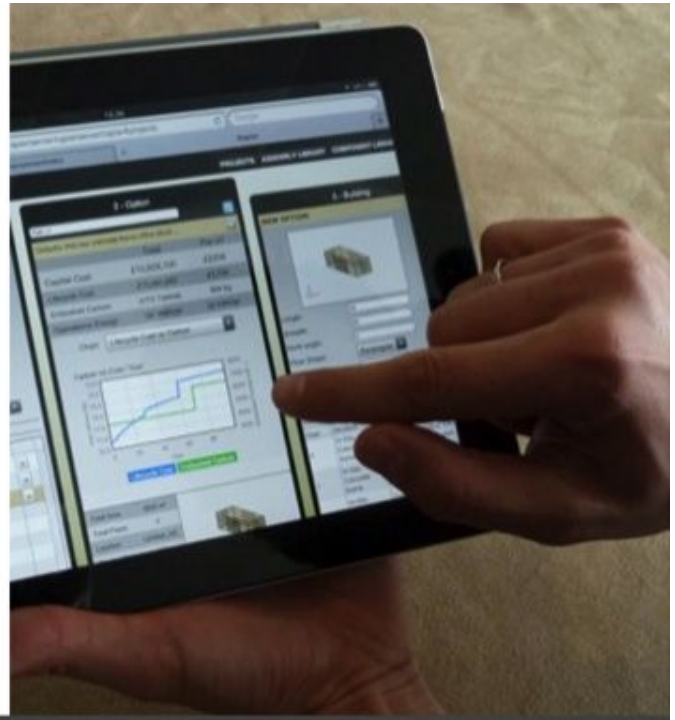
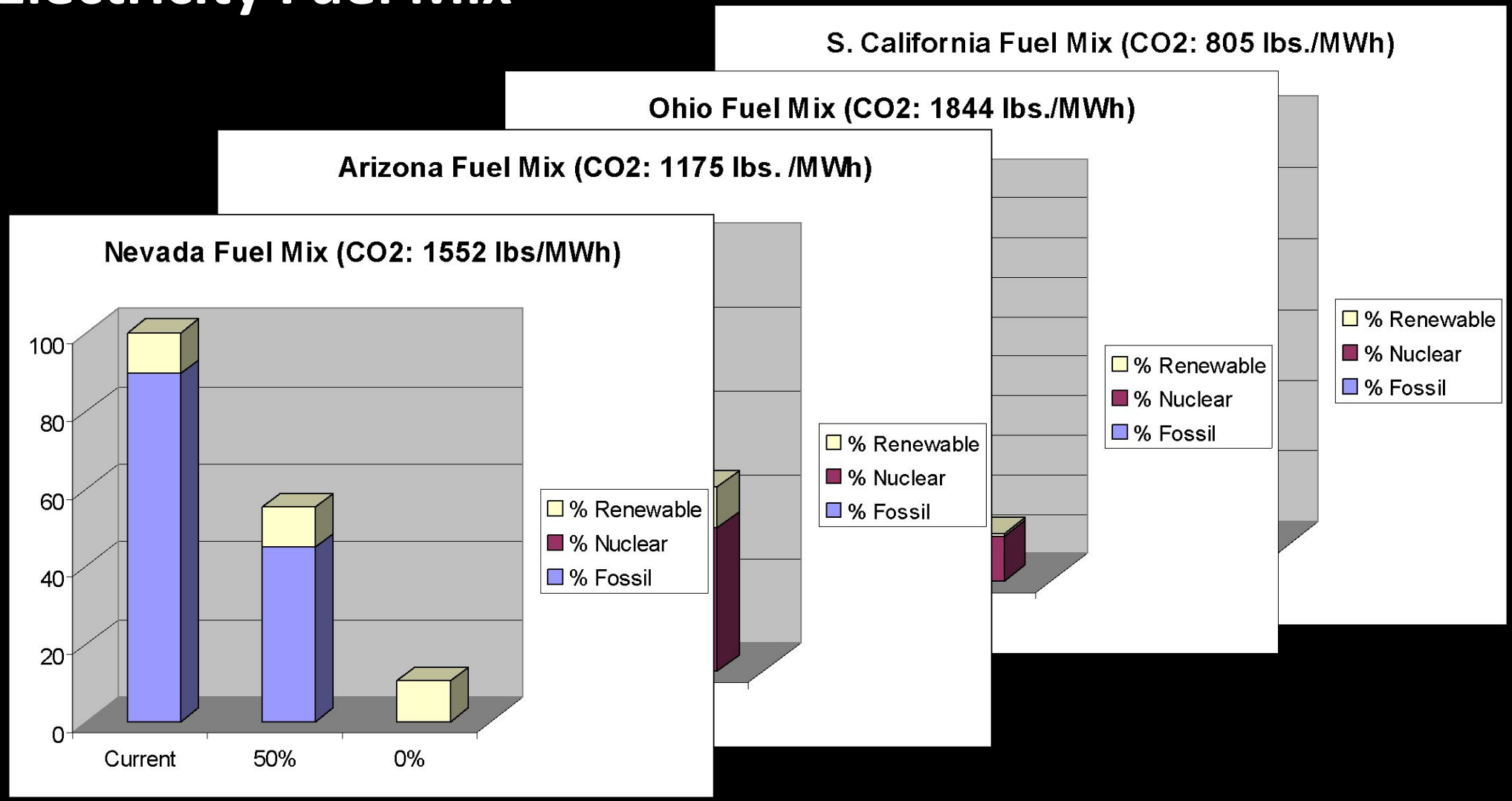


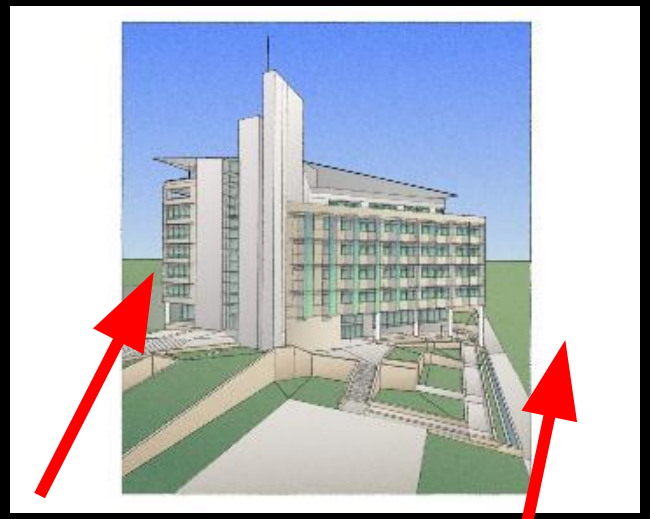
Image: rapiere.net Declaration: Architype are one of the founding partners of Rapiere

Carbon Footprint Varies - Regional Electricity Fuel Mix



A Carbon Neutral Building – Simple Example

Requires a Very Efficient Building



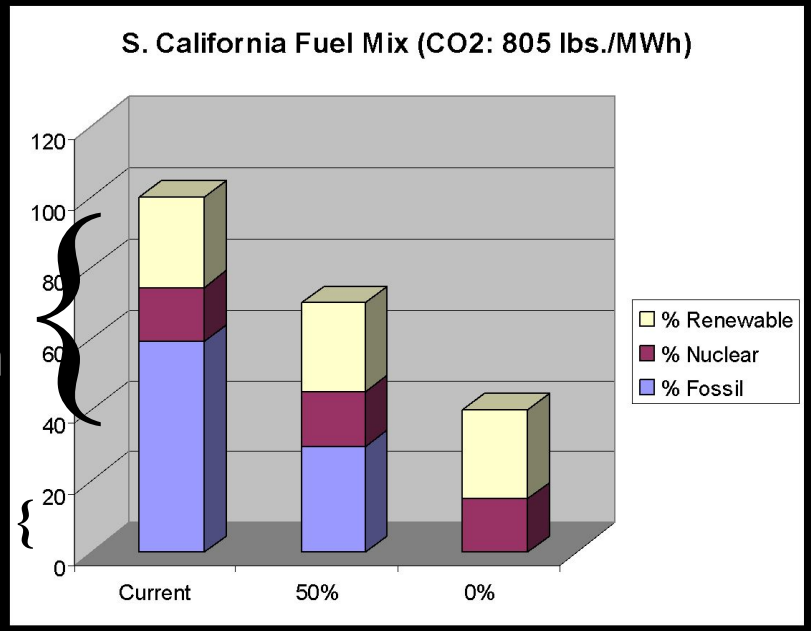
Onsite Renewable Generation

Biofuel Diesel Generator or Boiler

40% non-carbon

60% reduction in grid electricity

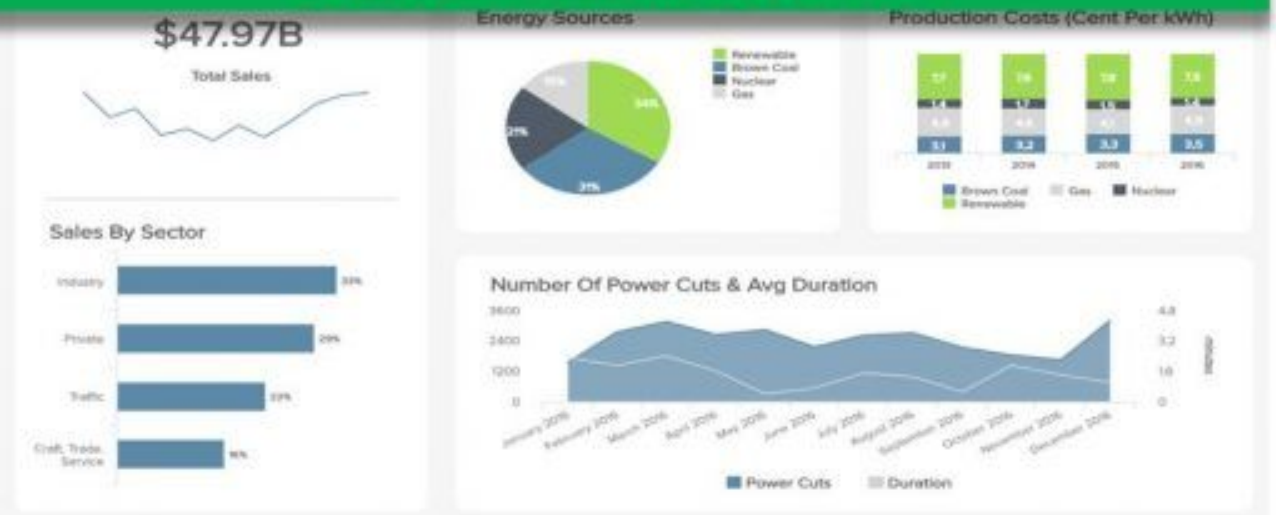
Grid Electricity



Financial Overview

Project Management Overview

CO2 Emissions Overview



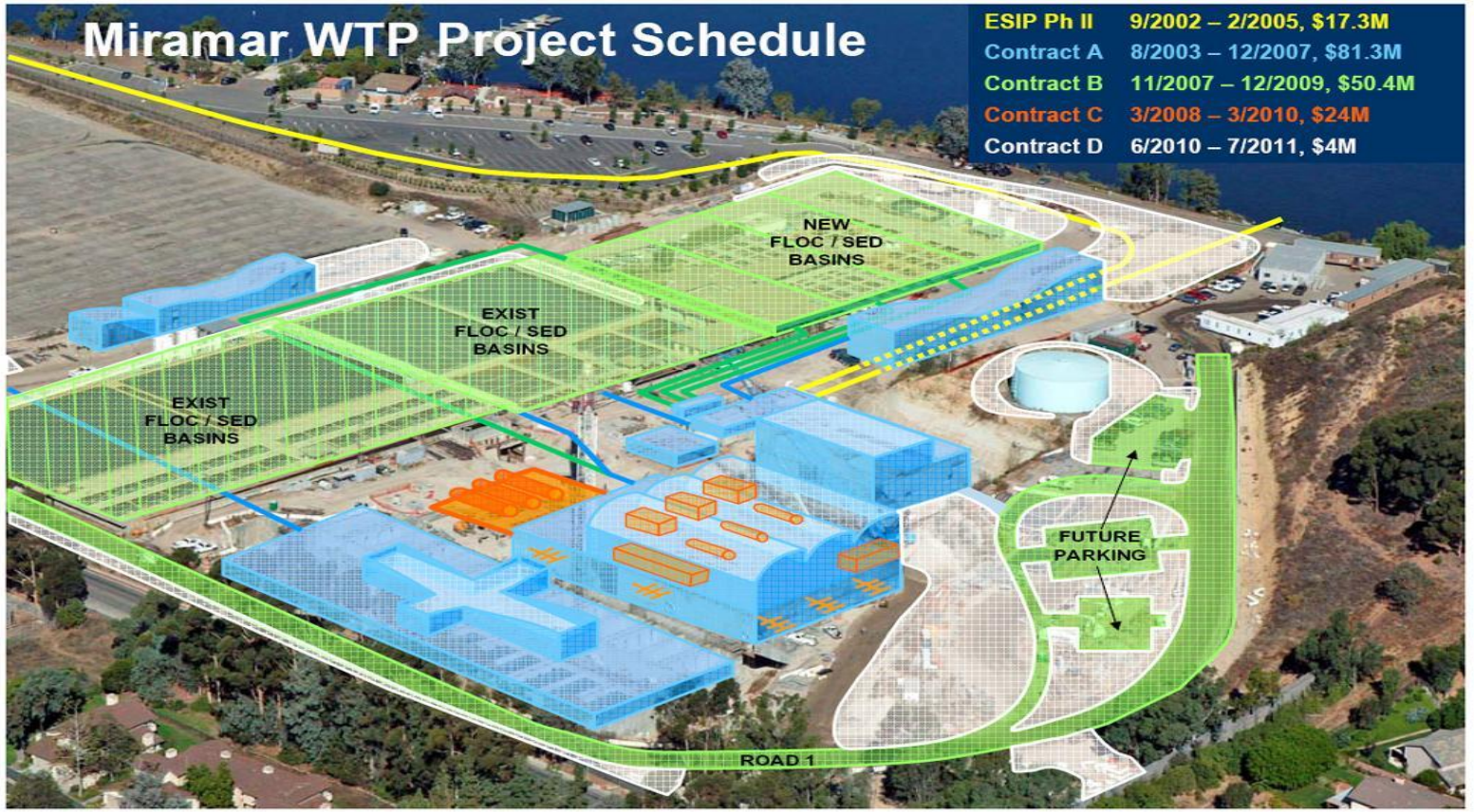
Quality & Safety Overview

Water

- BIM helps to quantify the amount of water used in a building by calculating the number of fixtures (sinks, toilets, etc.) and their related water usage. This also helps us measure the potential for greywater reuse, which is highly beneficial for reducing demand on local water supplies. The amount of water available for harvesting can be calculated using BIM, based on the site, harvesting system, and the size of building.

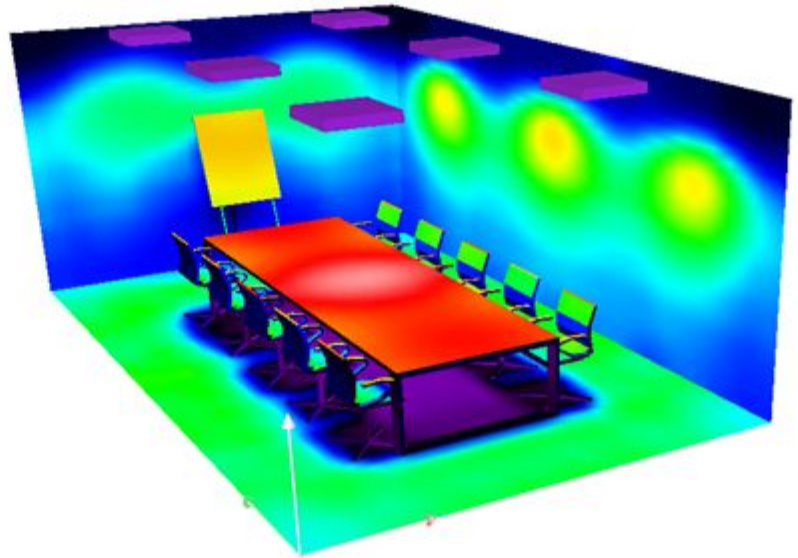
What are the main sustainability challenges that society faces today?

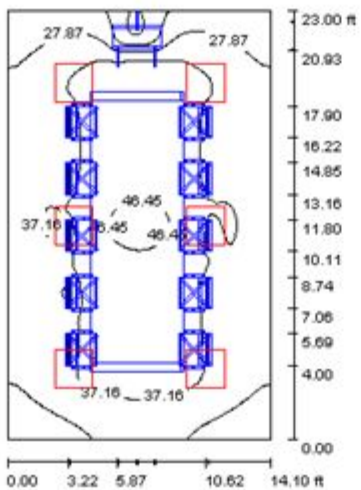
Maintaining and Expanding Access to Fresh Water



Aerial map of Miramar Water Treatment Plant Project with contract phase overlays, by L. Robin, 2009, courtesy The City of San Diego, California

Meeting Room Lighting

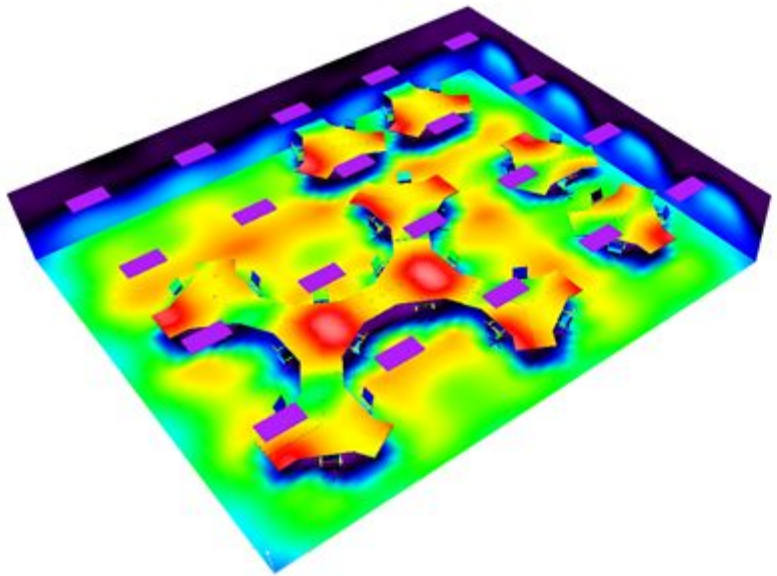


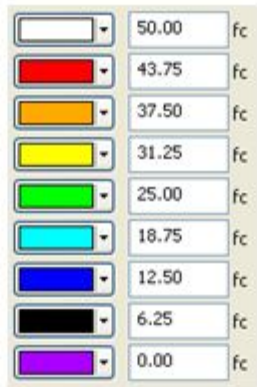


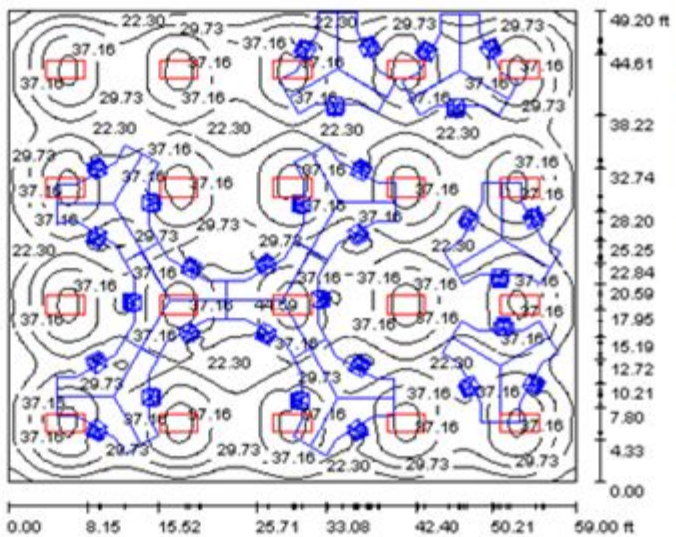
Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3x14 W	6	288	375

→ Installed LPD = **9.5 W/m²**

Open Office Space Lighting



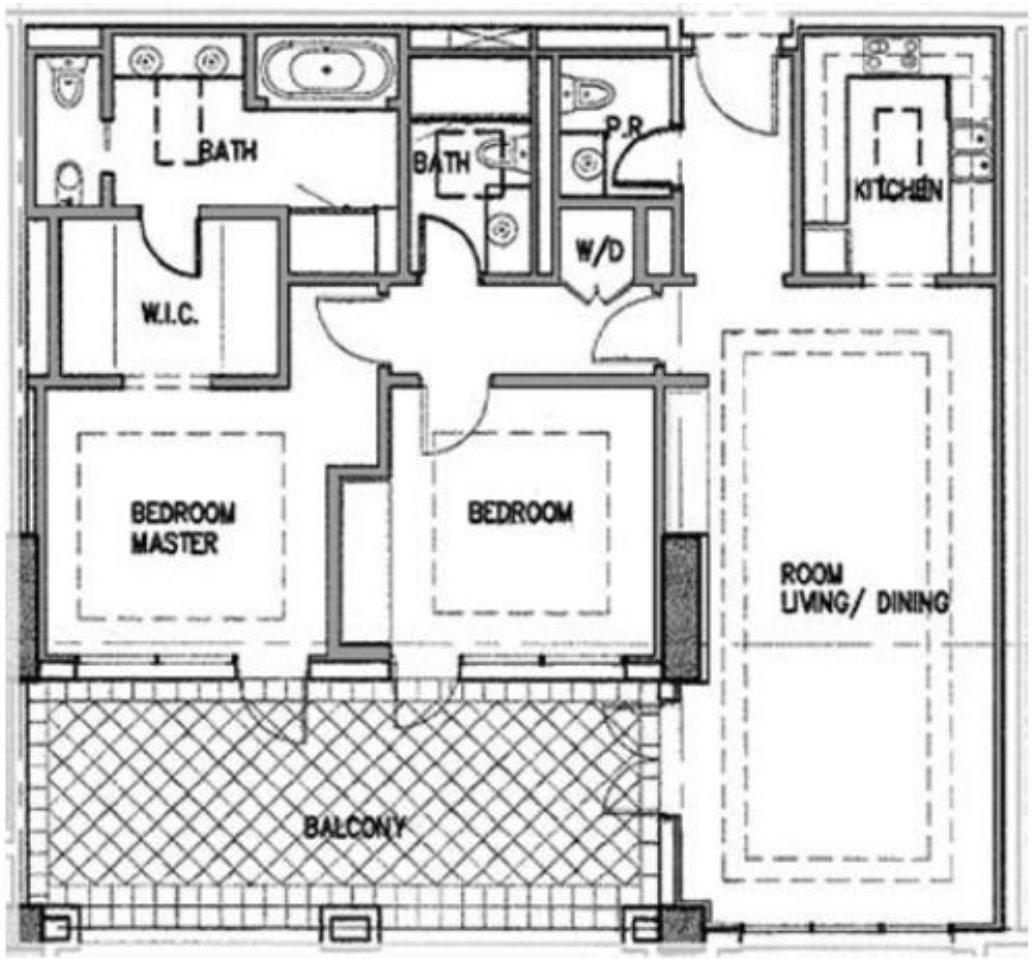


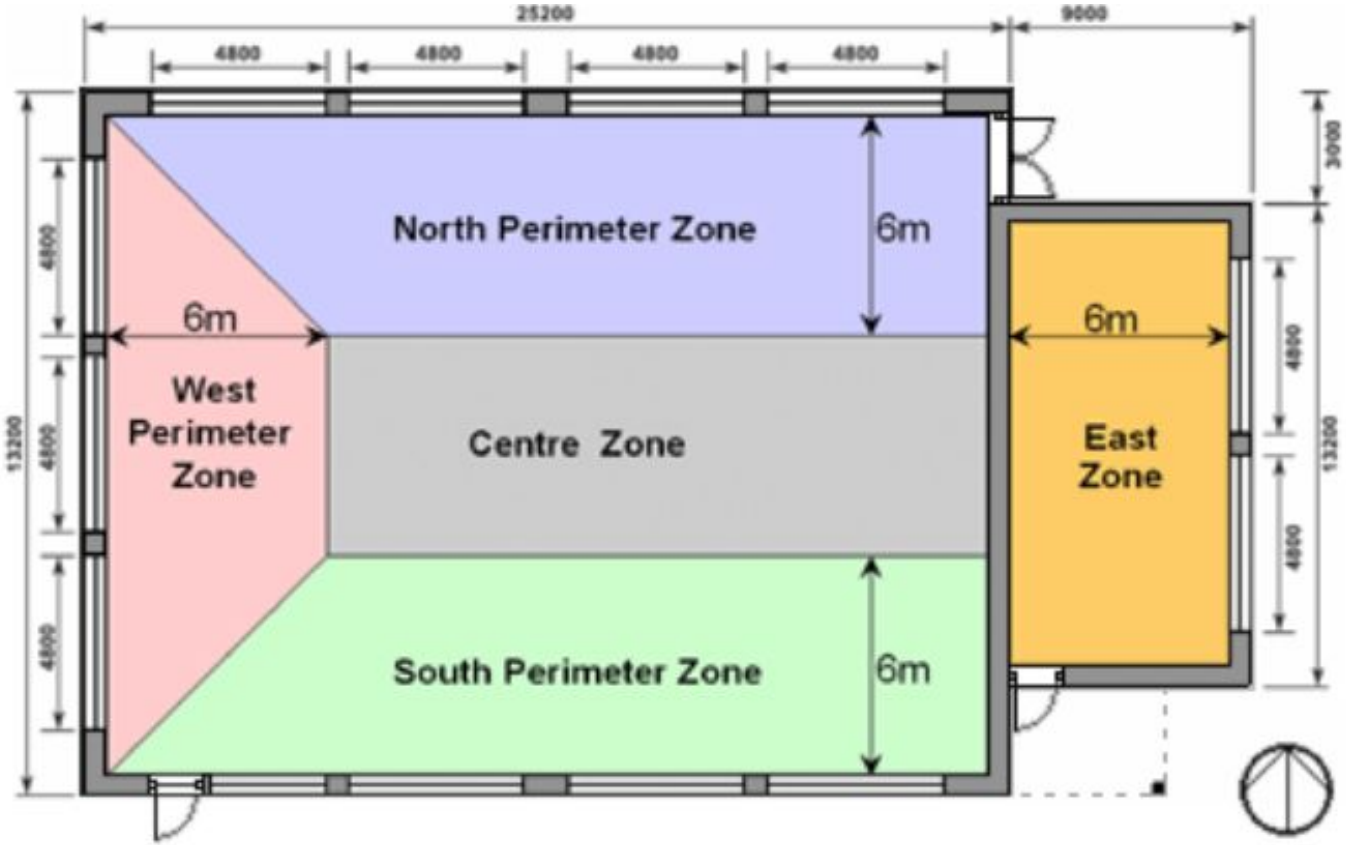


Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3 x 28W	20	1880	350

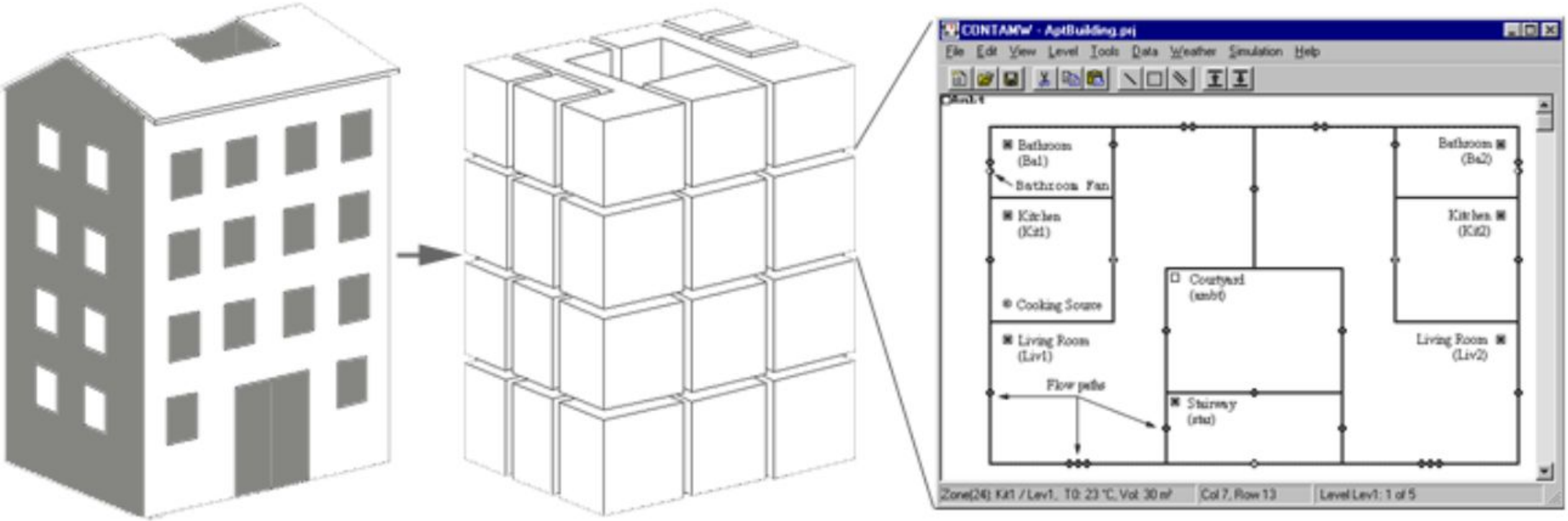
→ Installed LPD = **7.0 W/m²**

Thermal Zoning





Thermal Zoning



Criteria For Zoning An Energy Model Usage

• All rooms should have similar internal loads and usage schedules Temperature Control

• All rooms should have the same Tstat schedules Solar Gains

• Perimeter zones with windows: Min. one zone for each compass direction

• Unglazed exterior zones can be combined

• Consider shading!

Perimeter or Interior Location

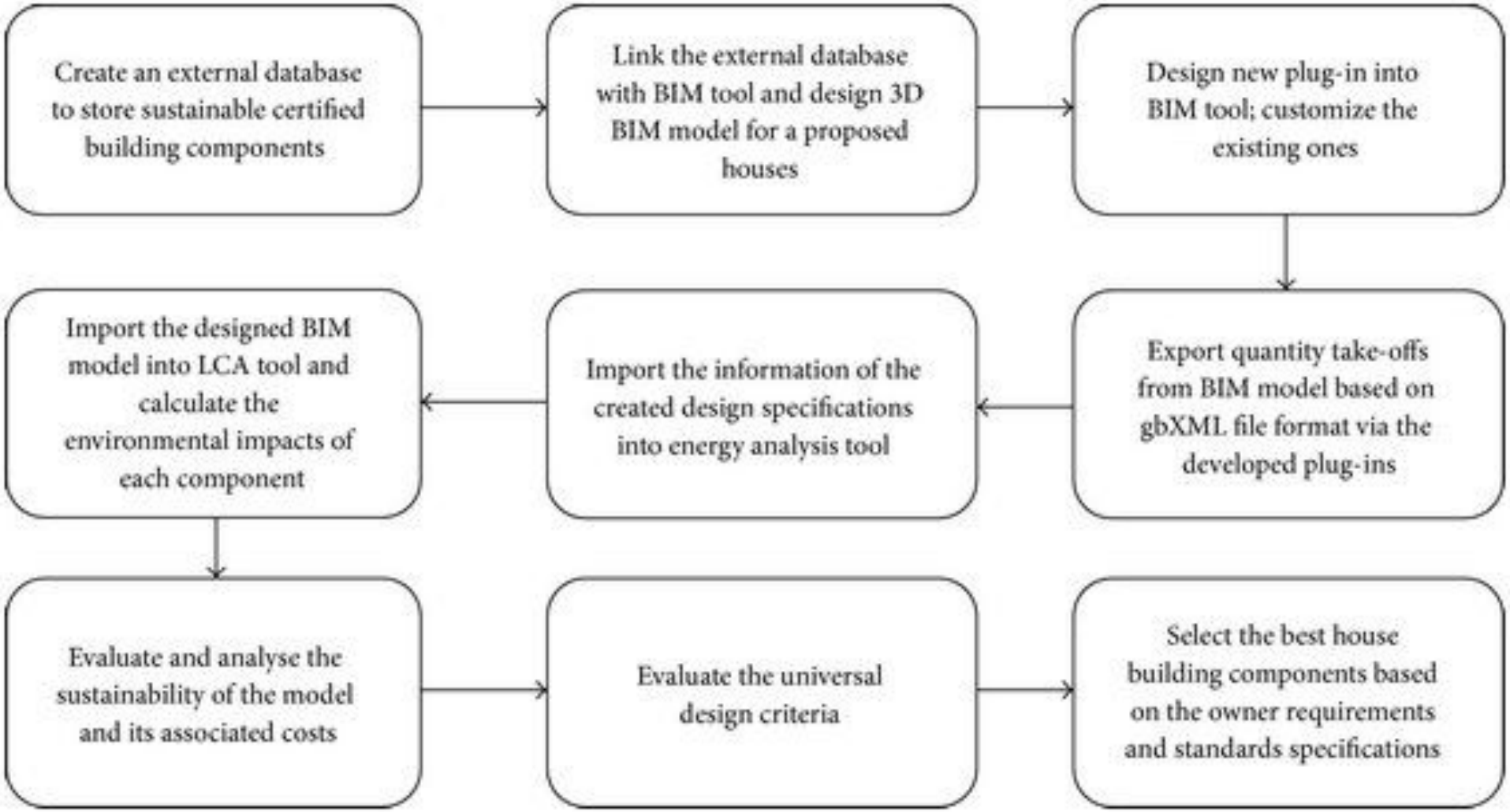
• 12-15’ perimeter zones often require winter heating

• Core spaces can require year round cooling Distribution System Type

•Combine rooms served by the same type of distribution system (i.e.

fan coil units)

Methodology of the integration system



R&D - INDICATE

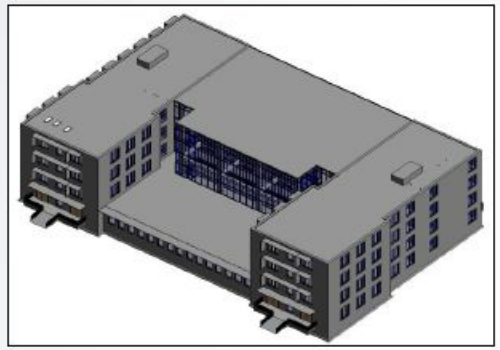
SUSTAINABLE INDICATORS FOR THE URBAN CONTEXT

Energy Use
Waste Network
Transport Network
Climate Change
Urban Heat Island Effect
etc

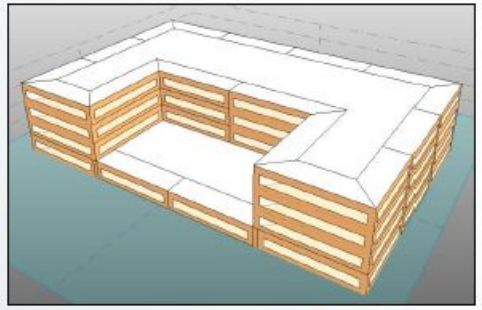
BIM to BPA platform and solutions…

Building Information Modeling

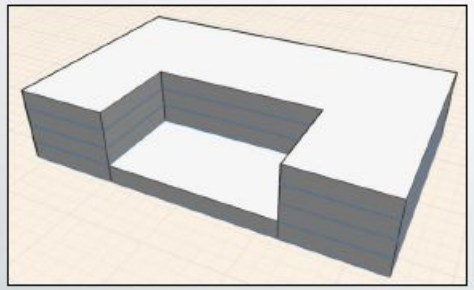
Revit
(building elements)



Vasari
(conceptual masses)



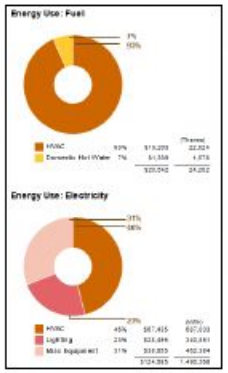
FormIt
iOS, Android, Web

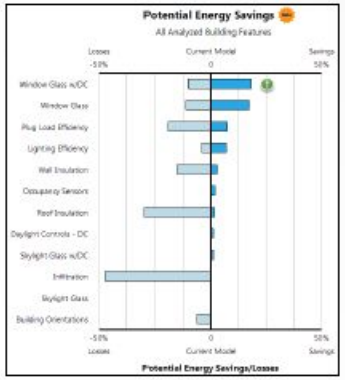


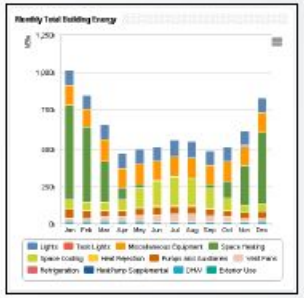
Conceptual to Detailed

Building Performance Analysis

← Energy →

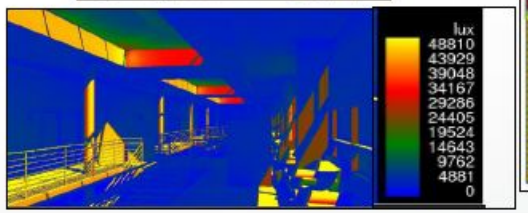


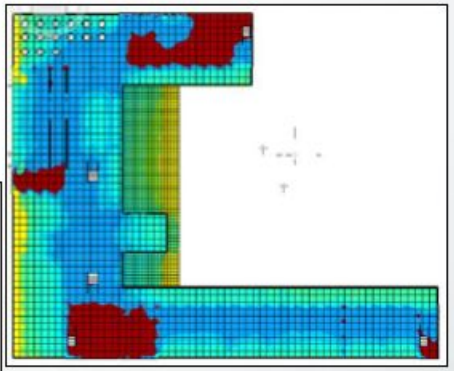




Green Building Studio & Project Solon

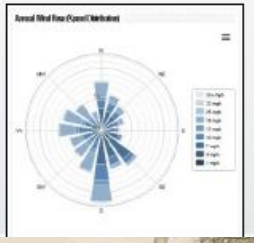
← Lighting →

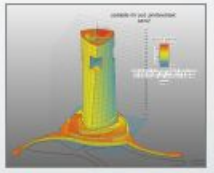


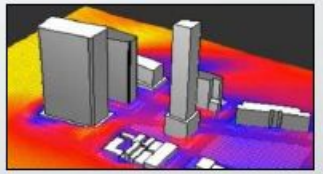


A360 Rendering & Lighting Analysis for Revit

← Climate, Solar & Airflow →



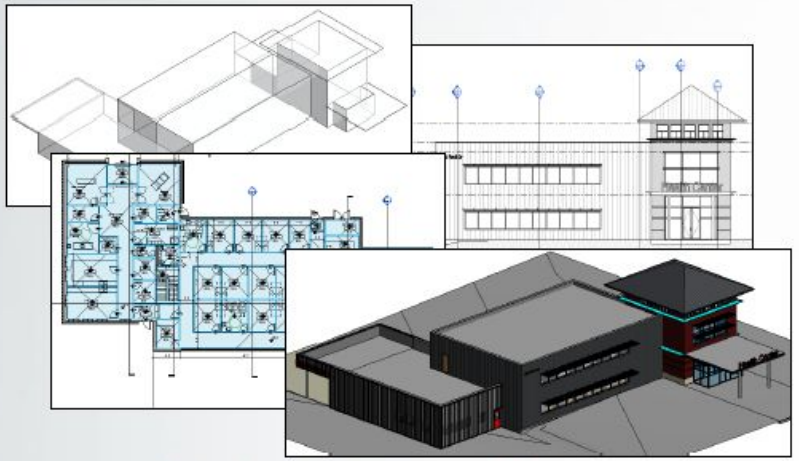




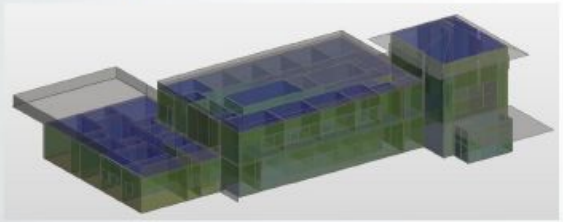
Climate Server 'Ecotect' features

Summary of Energy Analysis information & workflow…

Model → **Settings** → **Simulation**

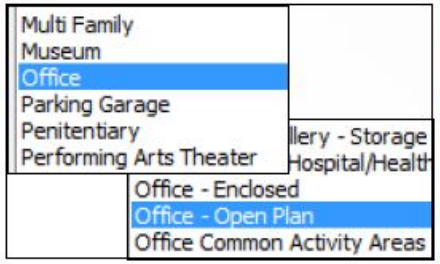


Project Documentation

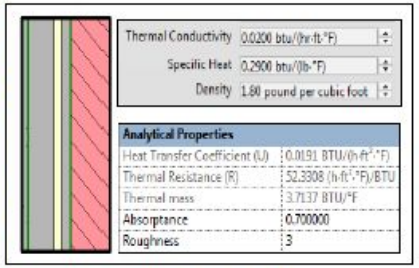


+ Energy Analytical Model (EAM)

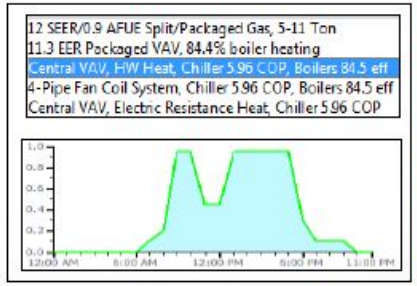
Location & Climate Data



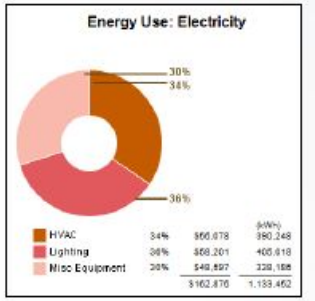
Building & Space Type Data

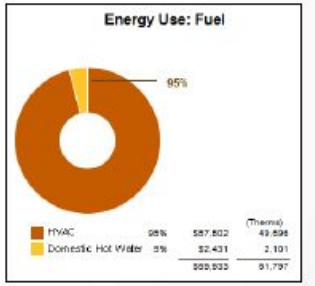


Materials Data

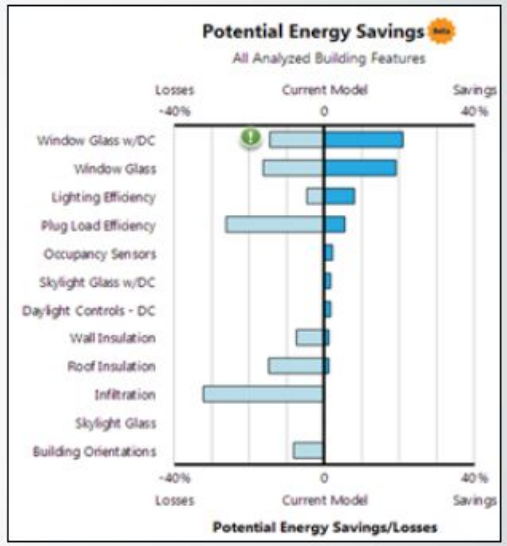


Systems & Operations Data





Energy Use & Cost



Potential Energy Savings

Feedback

Export

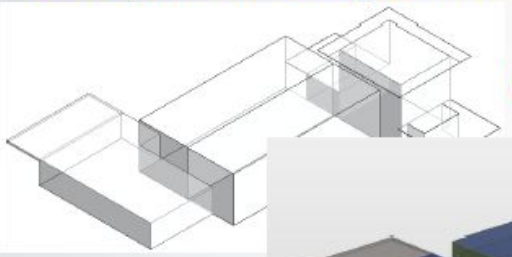
gbXML

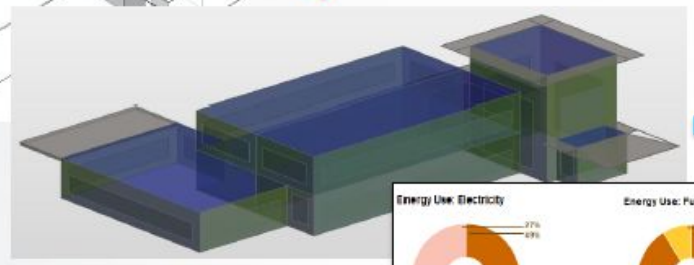
DOE-2

EnergyPlus

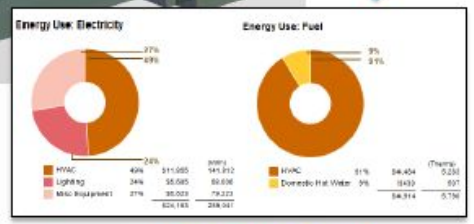
Revit Energy Analysis Features & Workflows…

Conceptual Massing elements



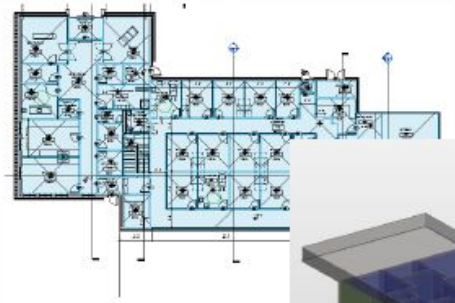


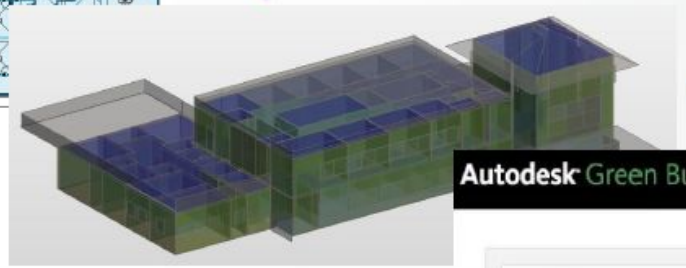
Energy Analytical Model



Energy Analysis

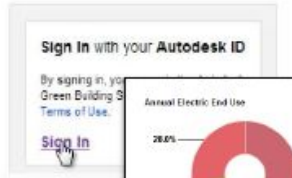
Room/Space elements



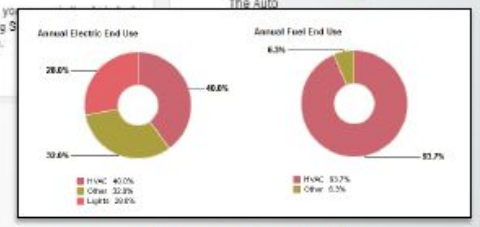


Energy Analytical Model
(gbXML export)

Autodesk Green Building Studio



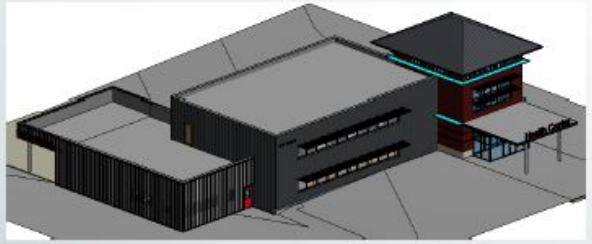
GBS

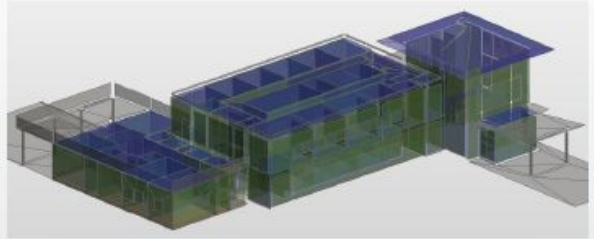


Energy Analysis

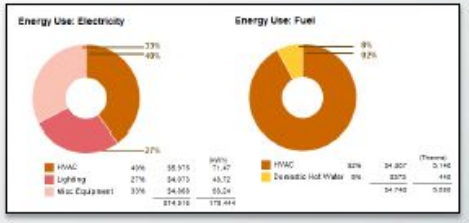
Typically fastest and most reliable with ‘real’ architectural Revit models

Building elements





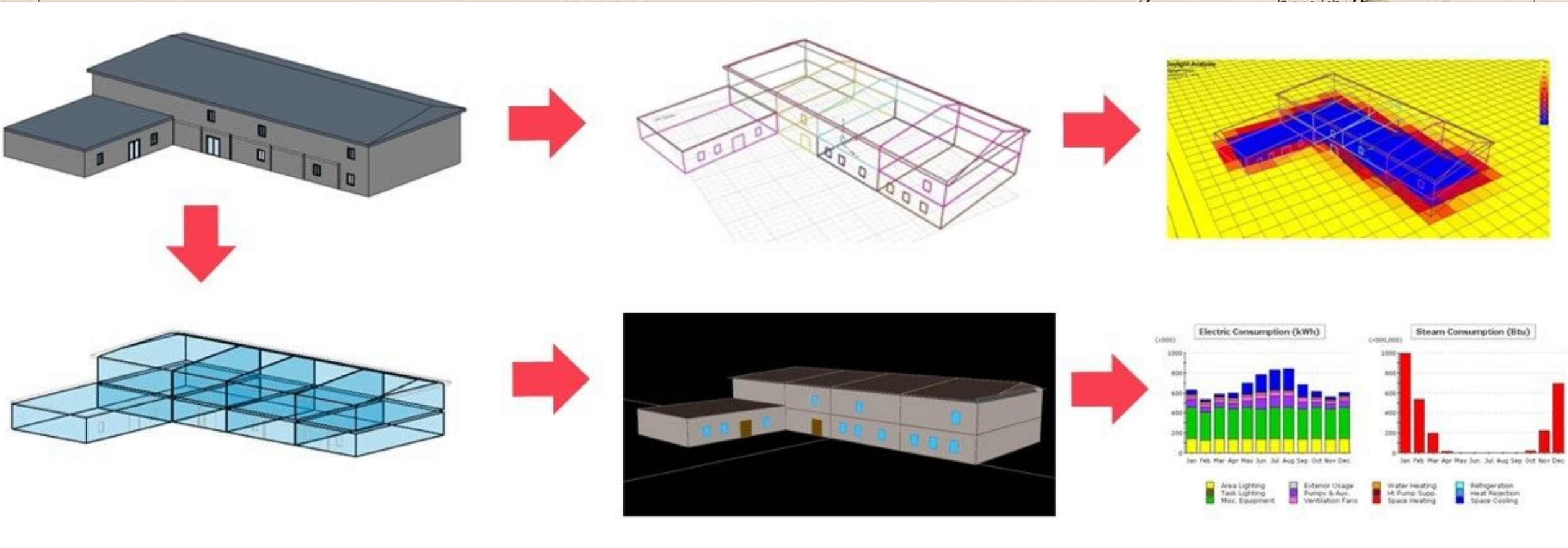
Energy Analytical Model

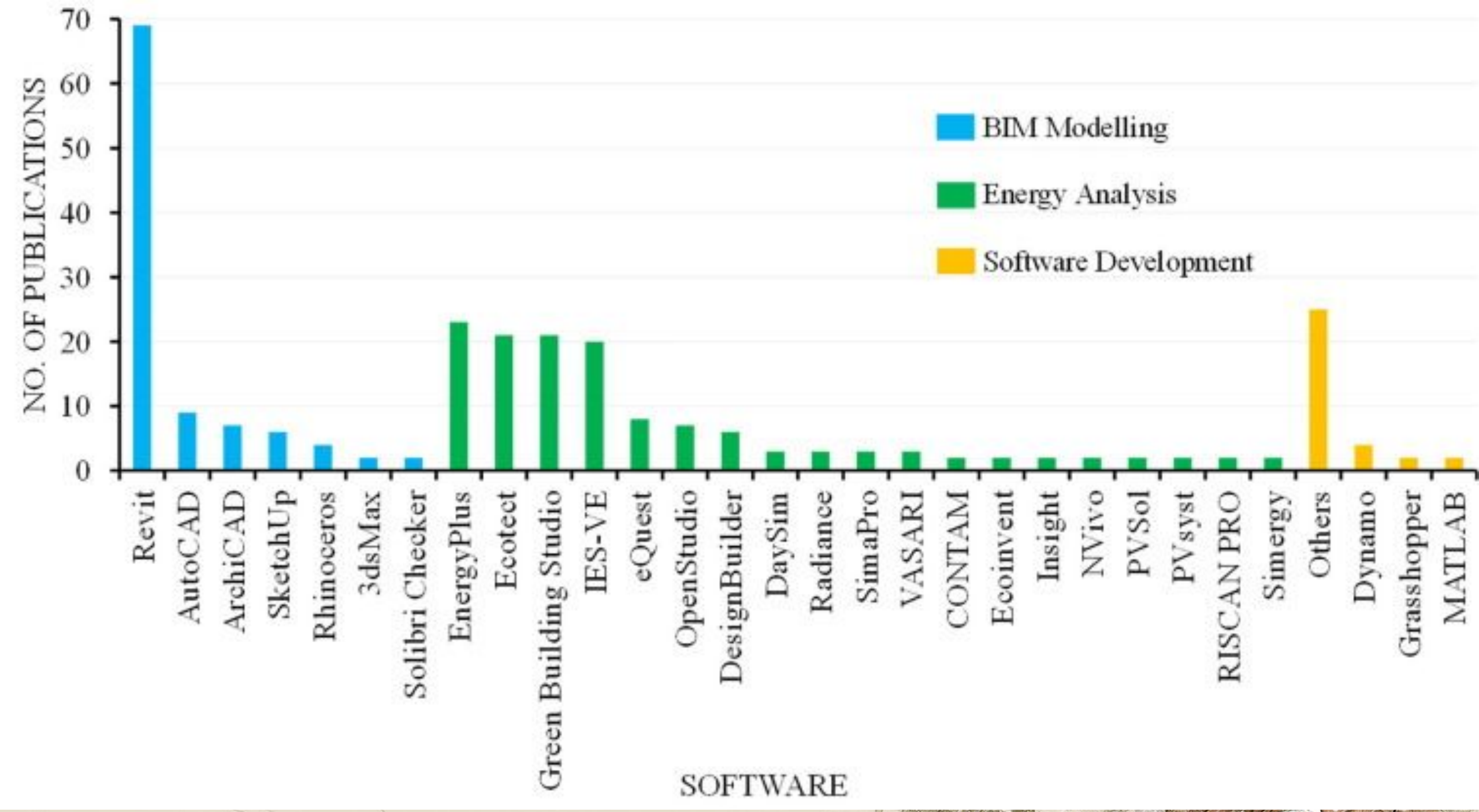


Energy Analysis

SOFTWARE

"Software doesn't design sustainable buildings, people do." – Elrond Burrell




NO. OF PUBLICATIONS
70
60
50
40
30
20
10
0
BIM Modelling
Energy Analysis
Software Development
Revit
AutoCAD
ArchiCAD
SketchUp
Rhinoceros
3dsMax
Solibri Checker
EnergyPlus
Ecotect
Green Building Studio
IES-VE
eQuest
OpenStudio
DesignBuilder
DaySim
Radiance
SimaPro
VASARI
CONTAM
Ecoinvent
Insight
NVivo
PVSol
PVsyst
RISCAN PRO
Simergy
Others
Dynamo
Grasshopper
MATLAB
SOFTWARE

SOFTWARE

List of approved LEED software

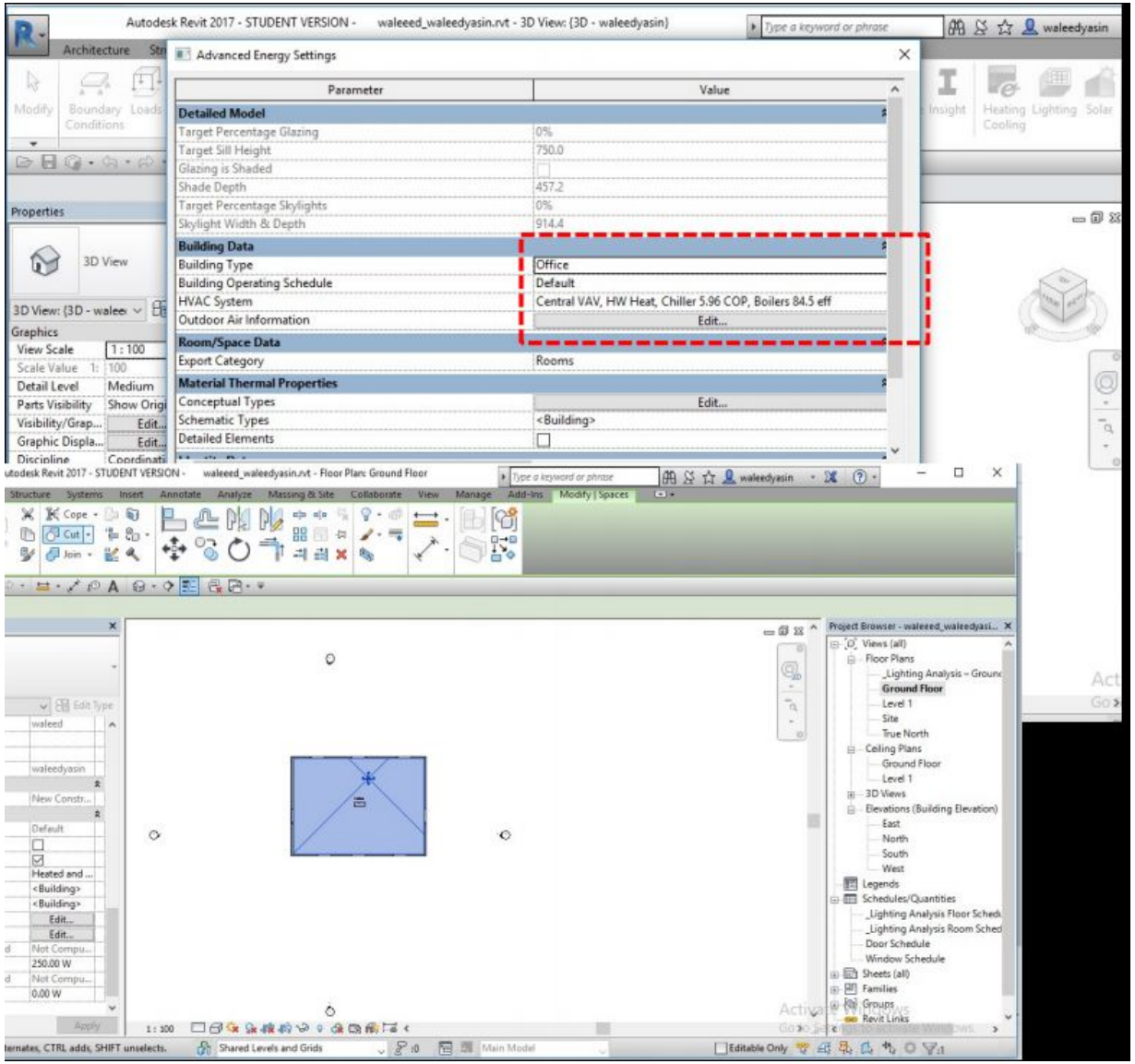
- DOE2
- eQUEST
- Visual DOE
- EnergyPlus
- EnergyPro
- HAP (Carrier HAP)
- TRACE 700 (Trane TRACE)
- BLAST (not mentioned within the LEED form, but listed in 90.1 section G2)
- IES (Integrated environmental solutions, listed in LEED Advanced energy modeling .

Energy simulation programs approved by Canada Green Building Council (CaGBC):

- eQuest
- EE4
- DOE-2
- EnergyPlus
- IES Virtual Environment,
- Hourly Analysis Program (HAP)
- TRACE 700
- EnergyPro v5.1.

ENERGY CONSUMPTION – HVAC LOAD – THERMAL COMFORT

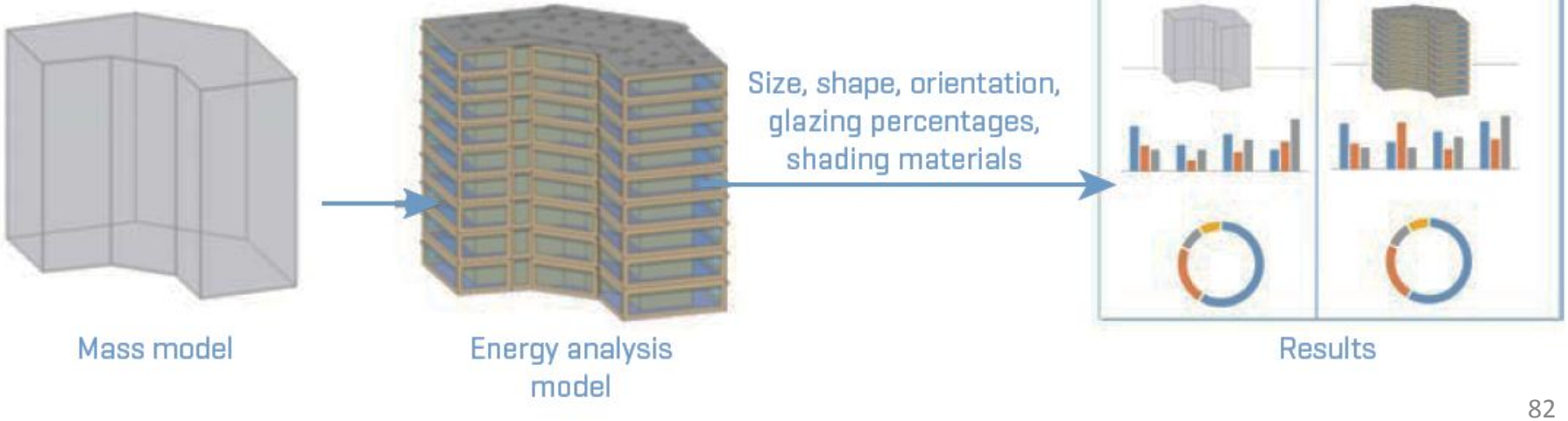
- FUNCTION
- OCCUPANCY
- CONSTRUCTION
- LIGHTING
- SCHEDULE
- HVAC SETPIONT
- DEMOSTIC WATER
- MECHANICAL VENTILATION •NATURAL VENTILATION •INFILTRATION •(ACH)



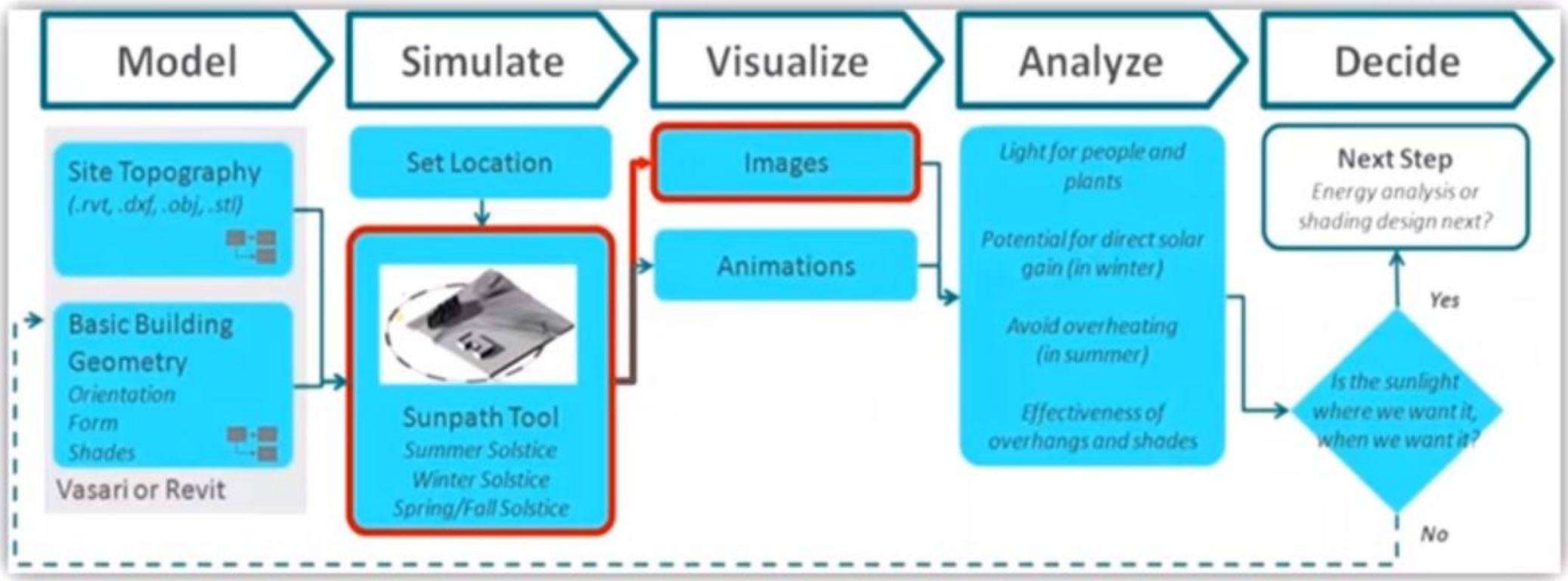
Energy Modeling

- Using BIM in the design process helps us evaluate energy efficiency and make recommendations for design alternatives that will enhance a building's performance. By combining BIM with specialized energy modeling software, every part of a building, from MEP (Mechanical, Electrical & Plumbing) systems to interior climate, can be simulated and optimized for energy efficiency.

Figure 46: Sustainability analysis using mass models



Solar Studies Overview

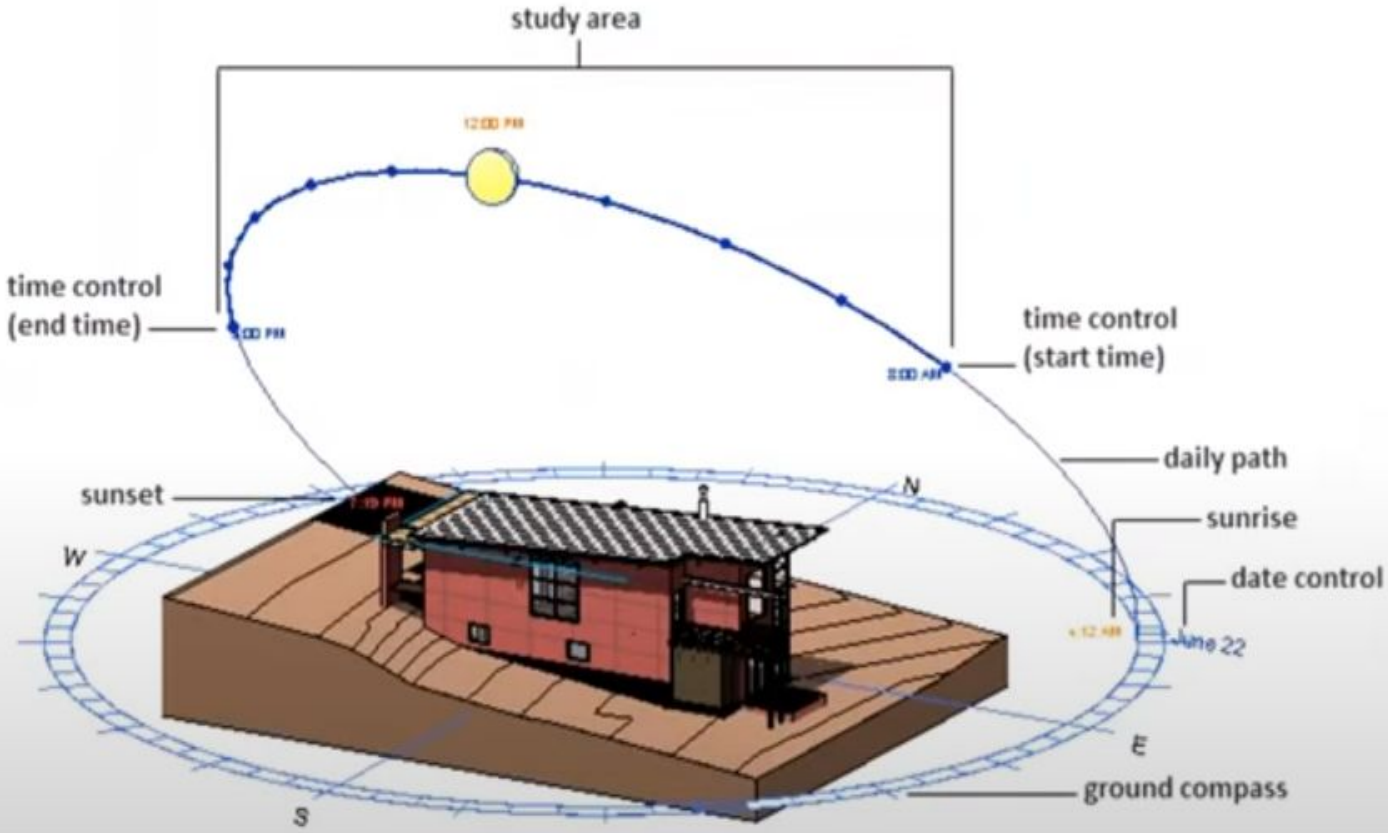


By showing the impact of natural light and shadows on your project, solar studies yield valuable information that can help support effective passive solar design. Use solar studies to visualize how shadows from terrain and surrounding buildings affect the site, and where natural light penetrates a building during specific times of the day and year

Solar Studies Overview

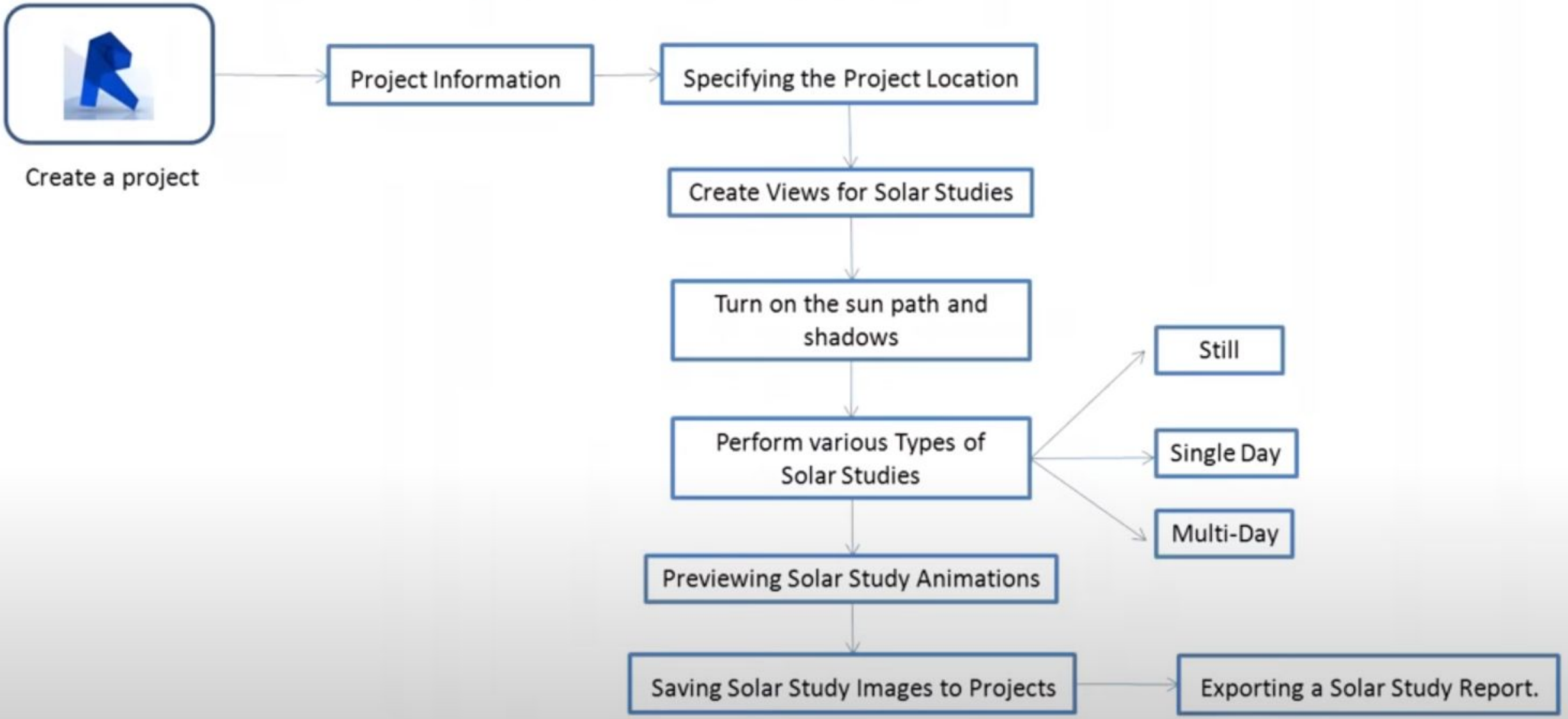
Sun path :-

The sun path is a visual representation of the sun's range of movement across the sky at the geographic location you specify for a project. The sun path displays in the context of your project and includes on-screen controls for positioning the sun at any point within its range of movement, between sunrise and sunset, throughout the year.



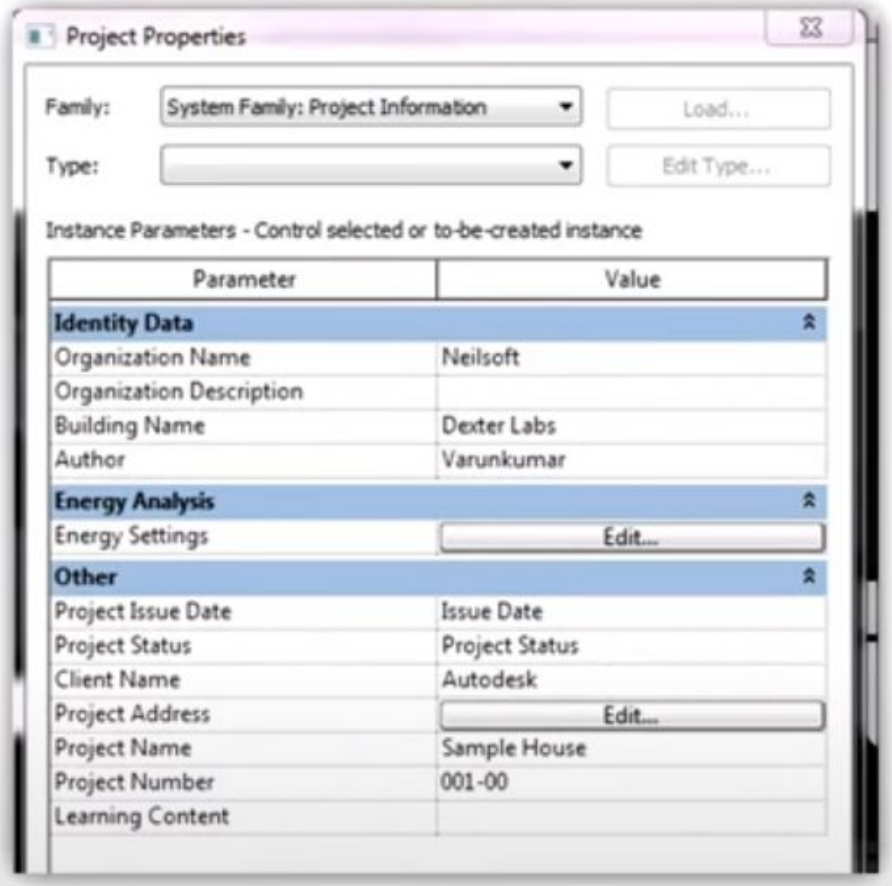
Solar Studies Workflow

Use the following workflow to create solar studies, using both the sun path and Sun Settings dialog.

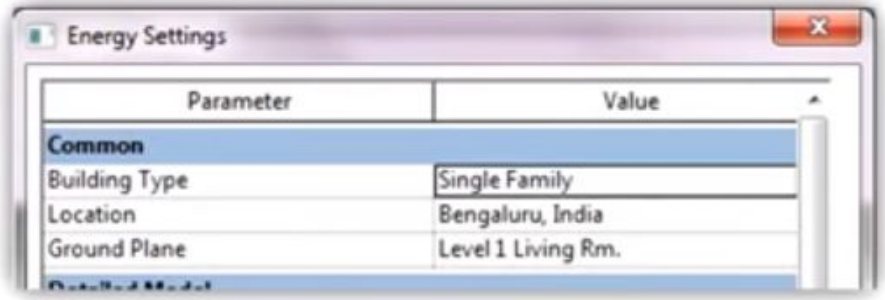


Solar Studies Workflow

Use the following workflow to create solar studies, using both the sun path and Sun Settings dialog.



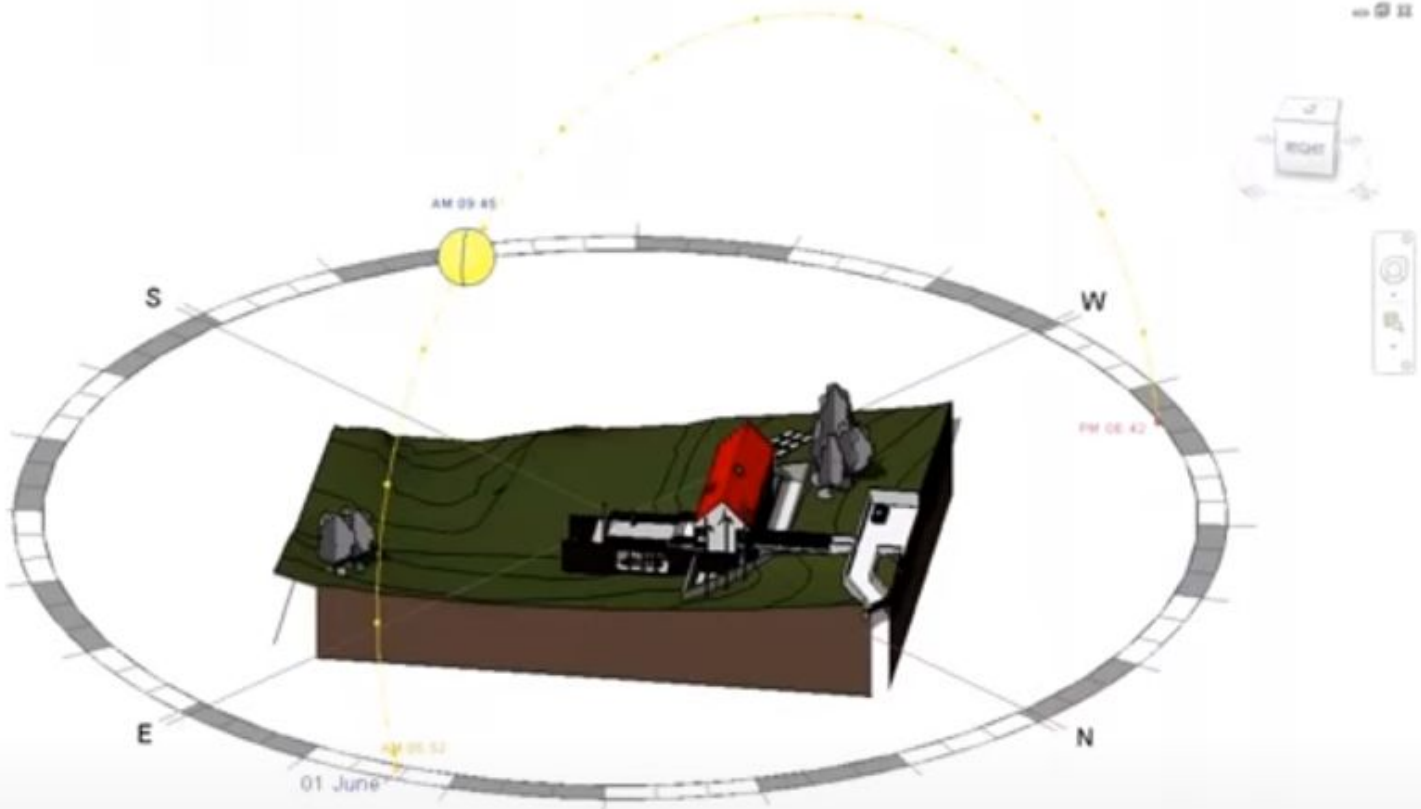
Project Information

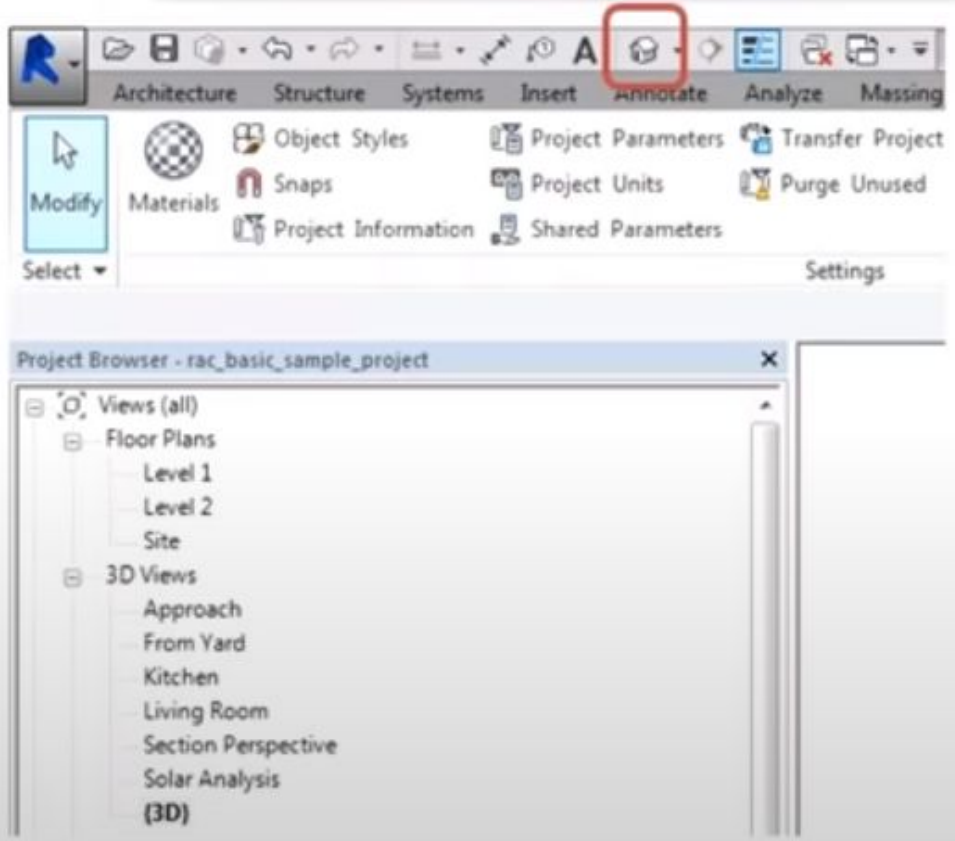


Specifying the Project Location

Solar Studies Workflow

Use the following workflow to create solar studies, using both the sun path and Sun Settings dialog.

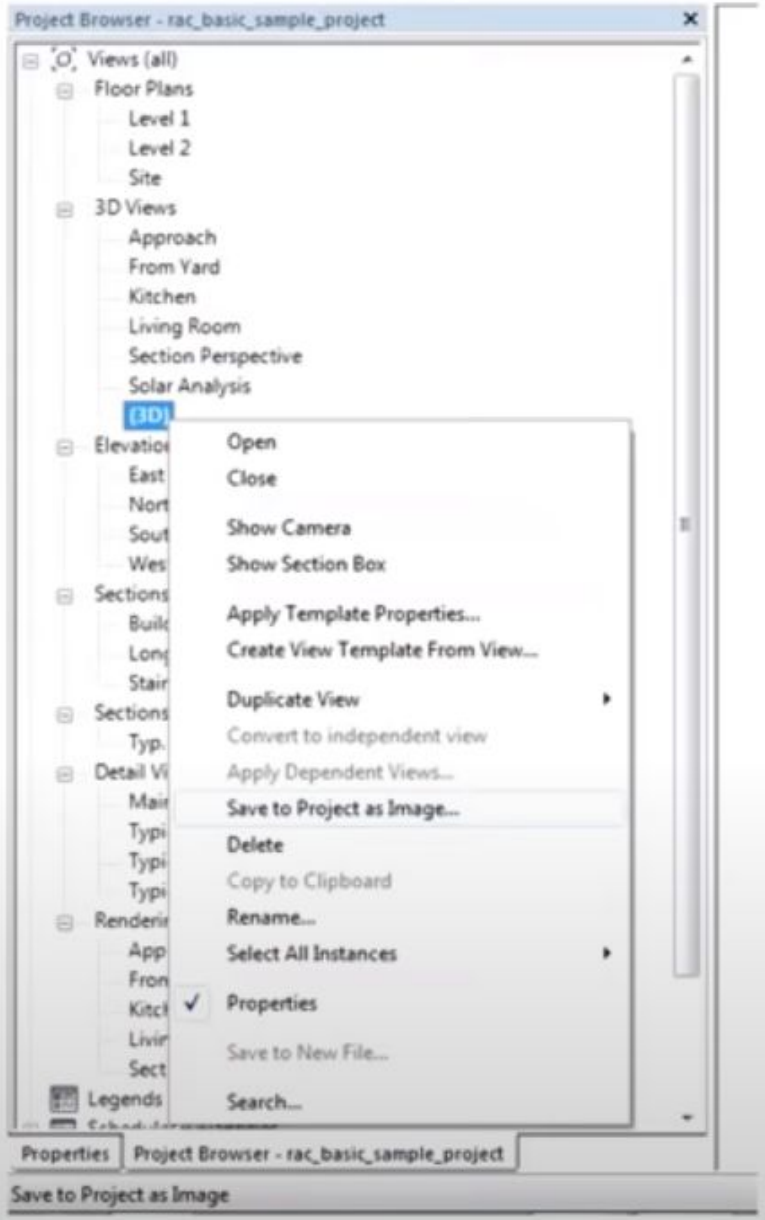


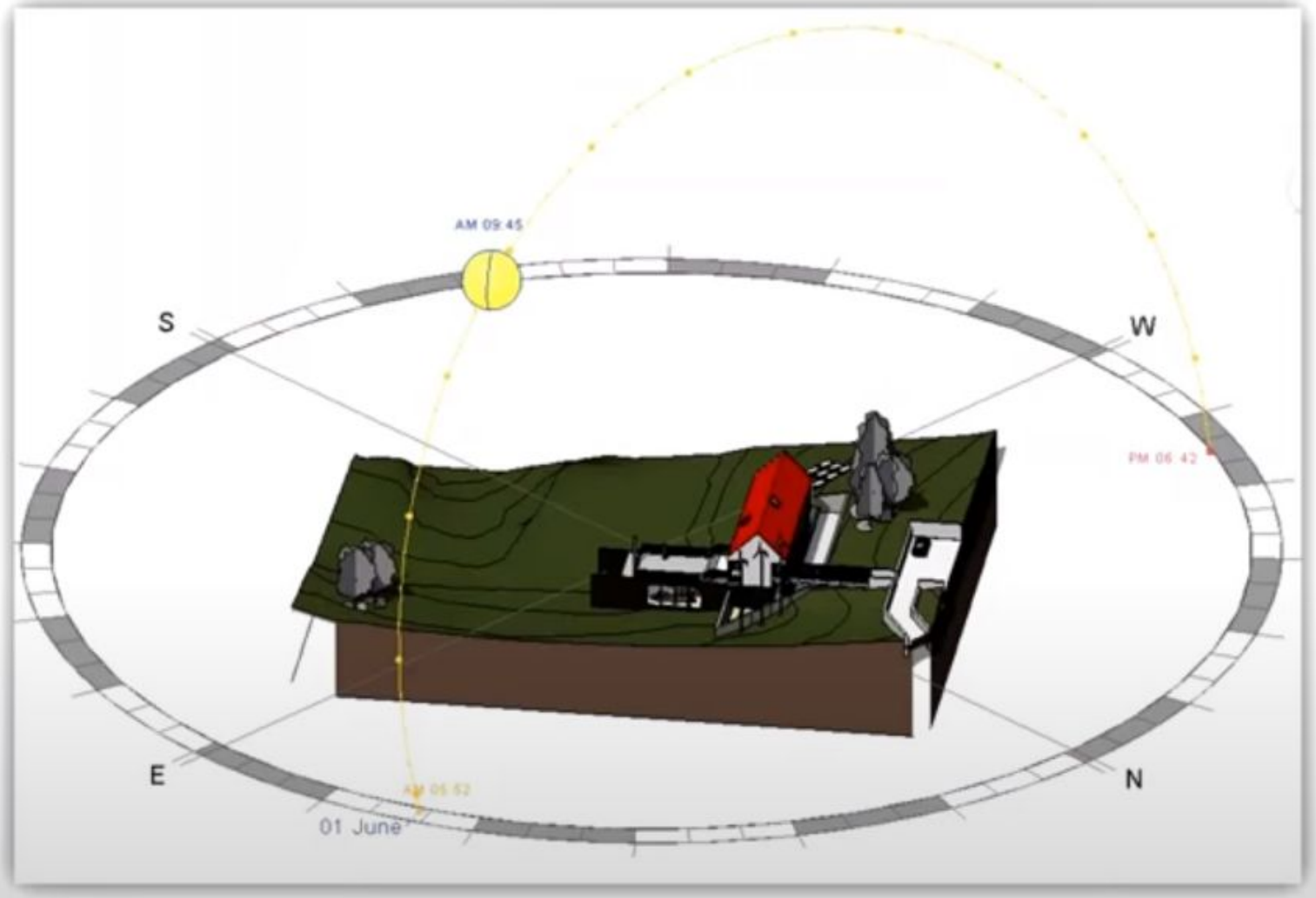


Create 3D Views for Solar Studies

Solar Studies Workflow

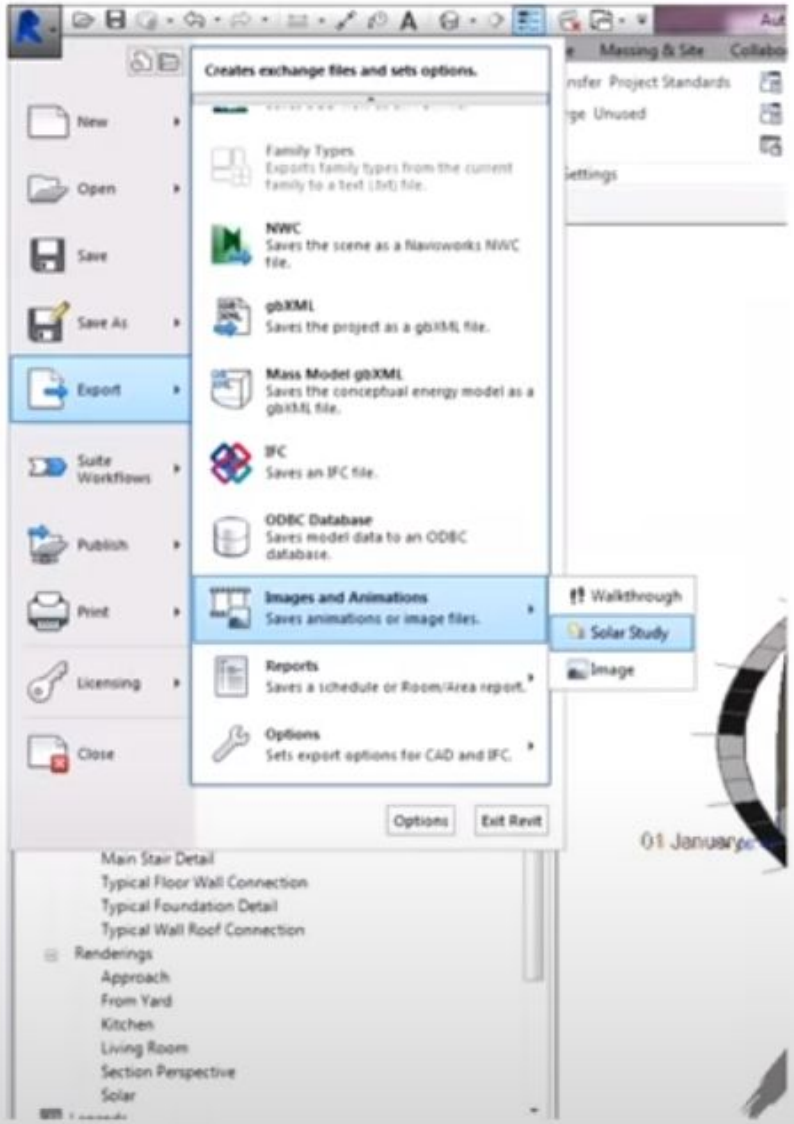
Save solar study images to projects for later reference.



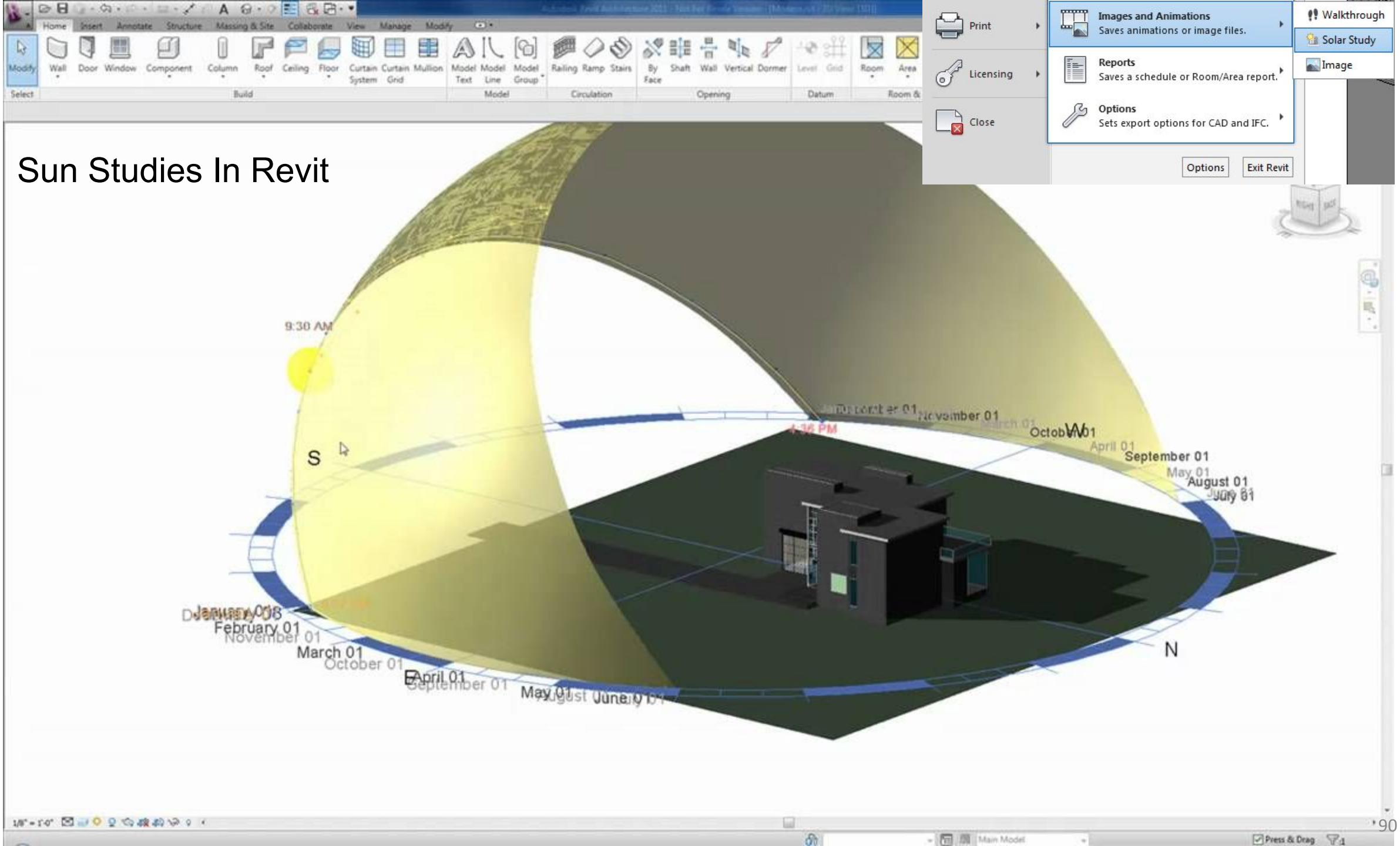


Solar Studies Workflow

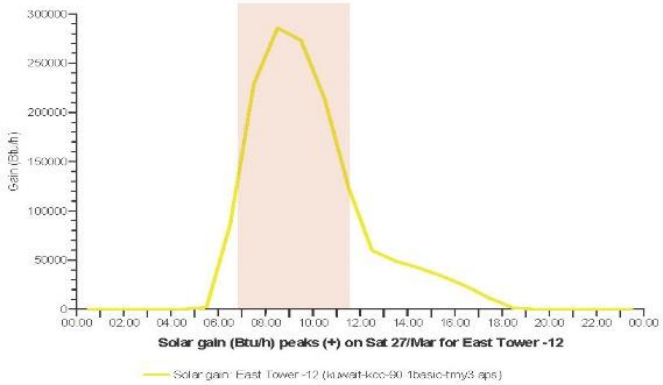
Exporting the Solar Study Animations

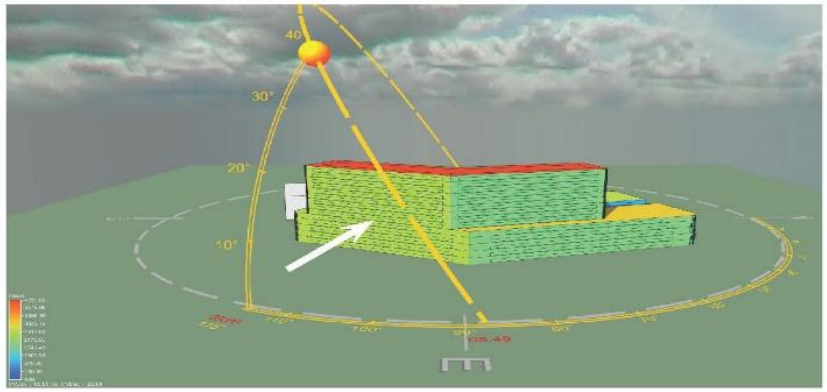


Sun Studies In Revit



Why BIM ,,Benefits of BIM,,



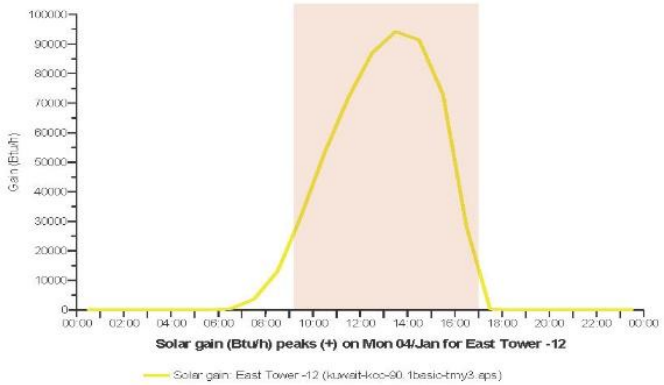


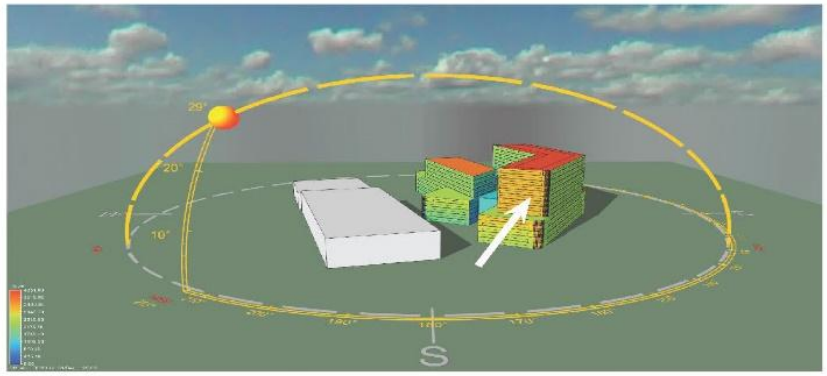
Analysis of total annual hours of sun exposure per major facade orientation. Provide shading to control the peak time of solar gain. Shading will reduce energy use and improve occupant comfort.

Red = Most , Blue = Least

EAST ELEVATION
Sun location: Horizontal 115 d / Vertical 40 d

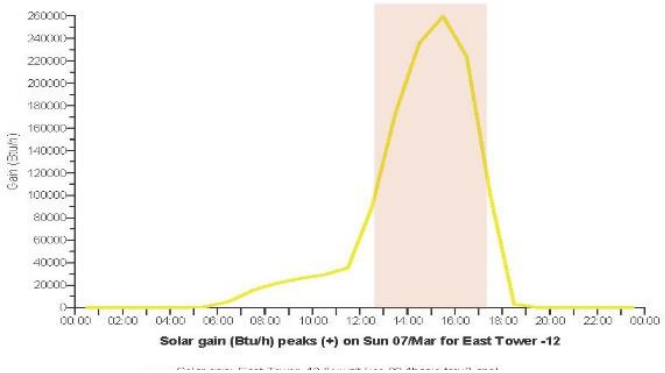
Shading approach: Both horizontal and vertical shading due to high sun angle.

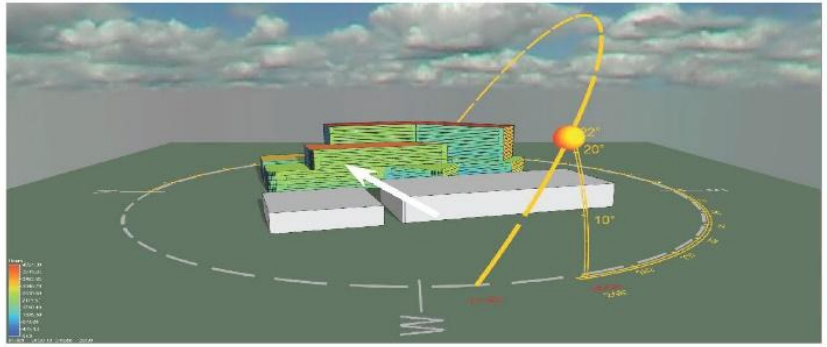




SOUTH ELEVATION
Sun location: Horizontal 213 d / Vertical 29 d

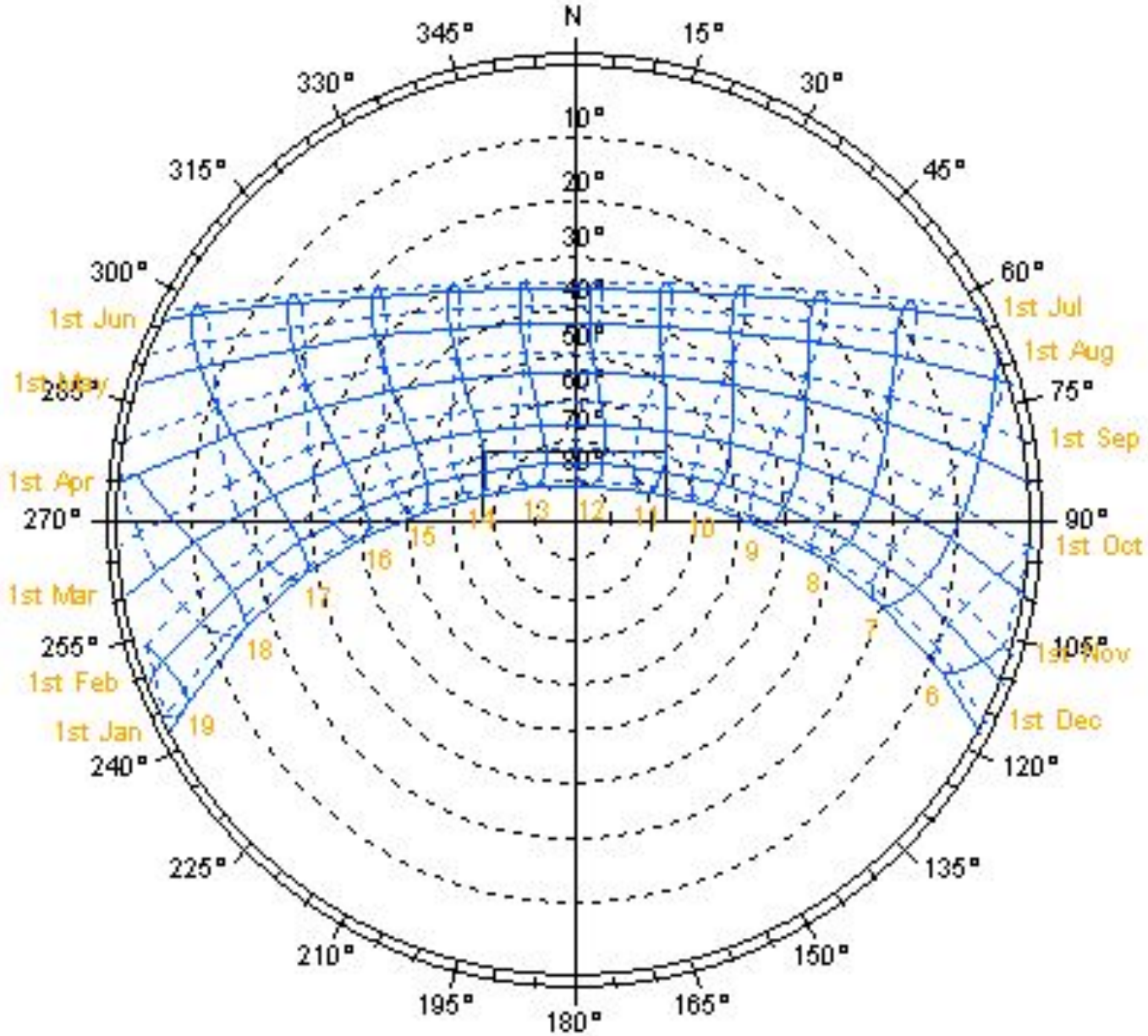
Shading approach: Horizontal shading with deep set windows.





WEST ELEVATION
Sun location: Horizontal 248 d / Vertical 22 d

Shading approach: Screen to control low sun angle.

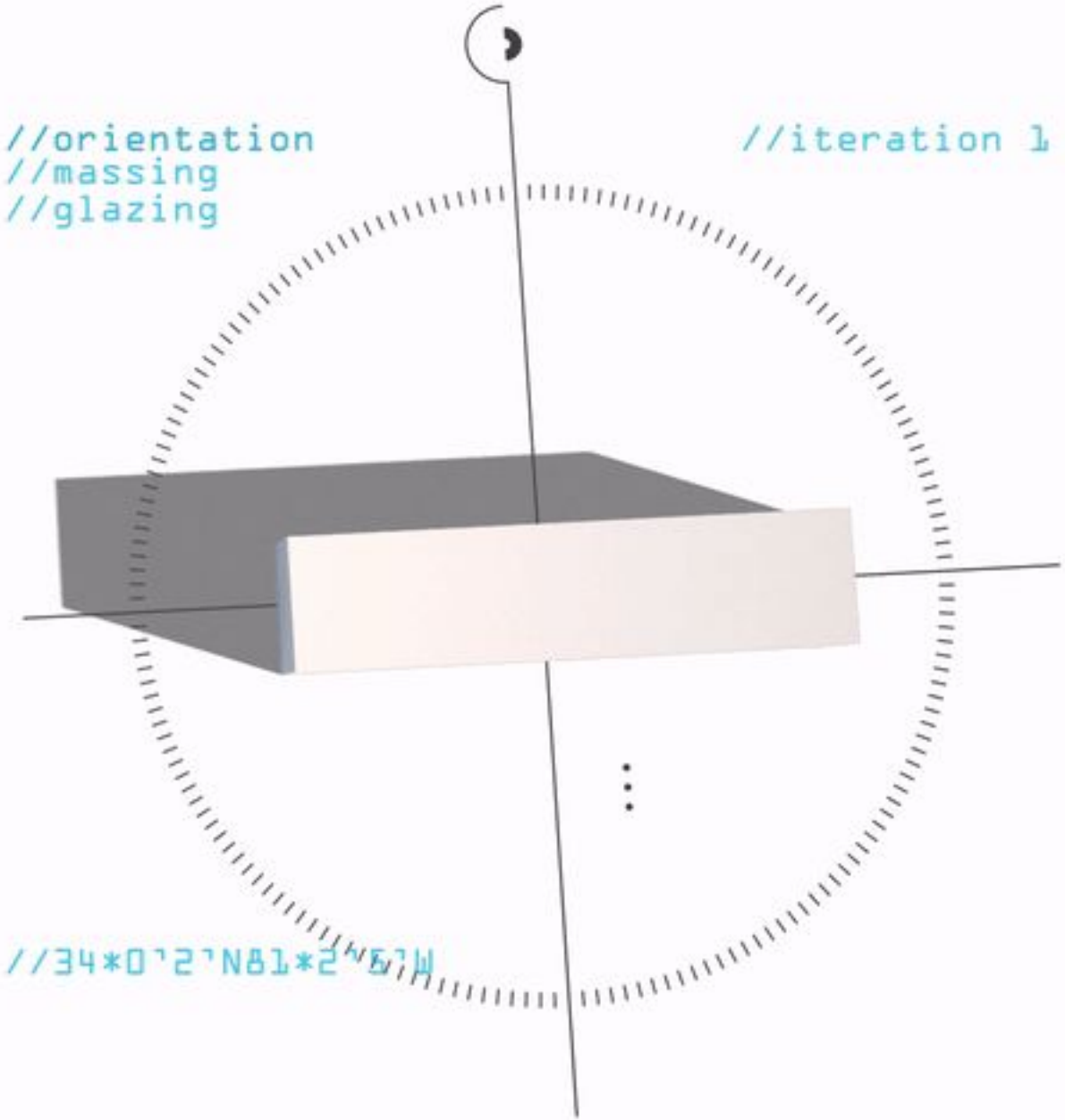


Make sure your diagram represents the right latitude...

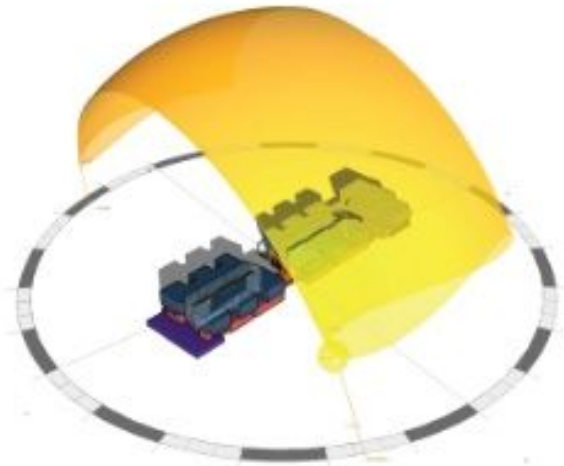
Real Time Feedback

Energy Use [EUI]

Life Cycle Cost Analysis [LCCA]



Mall Skylighting Preliminary Analysis

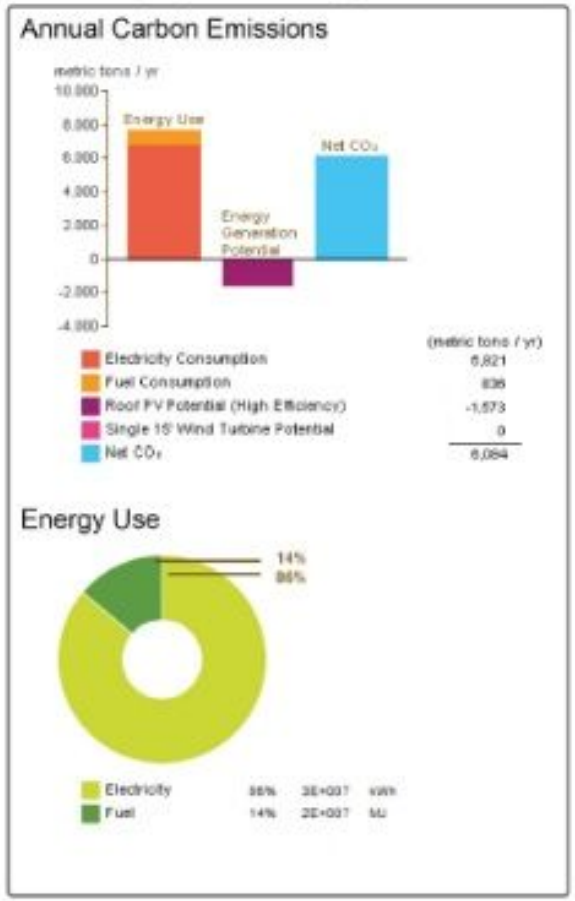


Annual Sun Exposure (8am - 5pm)

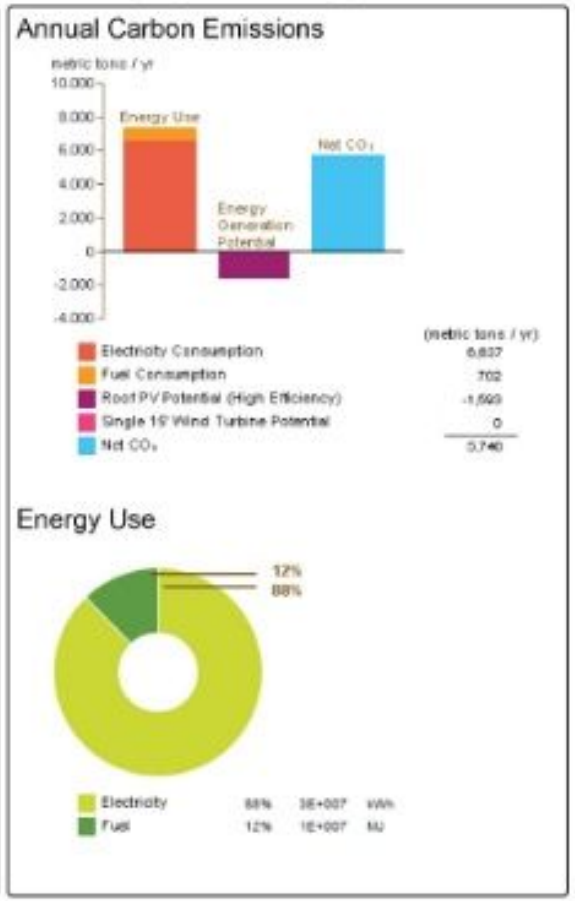
* Calculations assume 50% glazing on exterior faces throughout the rest of project, not including the theater

* The increase of efficiency is a percentage of the energy consumption over the entire project, not just the mall atrium spaces

95% Skylight Glazing



65% Skylight Glazing

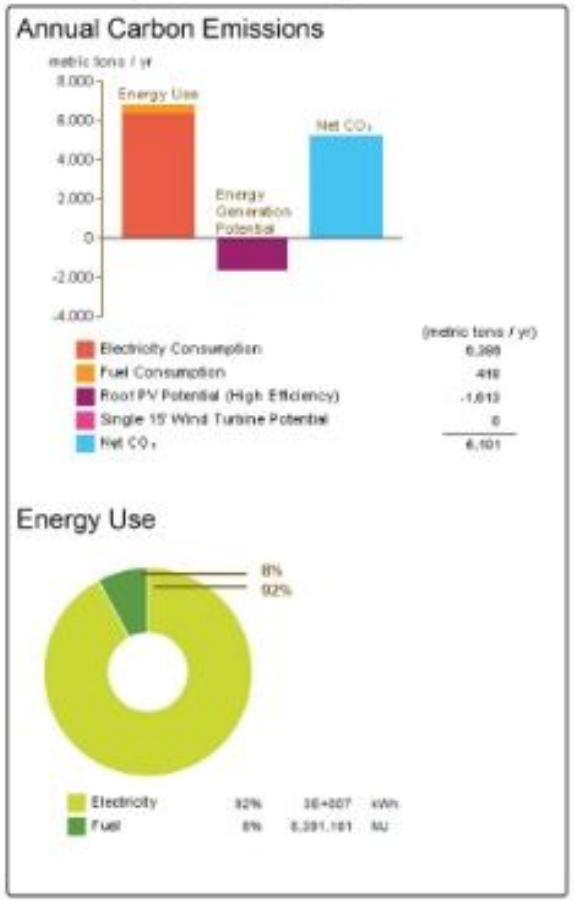


Efficiency Increase (Metric Tons /yr)

Elec. Consumption	-184 (2.7%)
Fuel Consumption	-134 (16.0%)

(Compared to 95% Skylight Glazing)

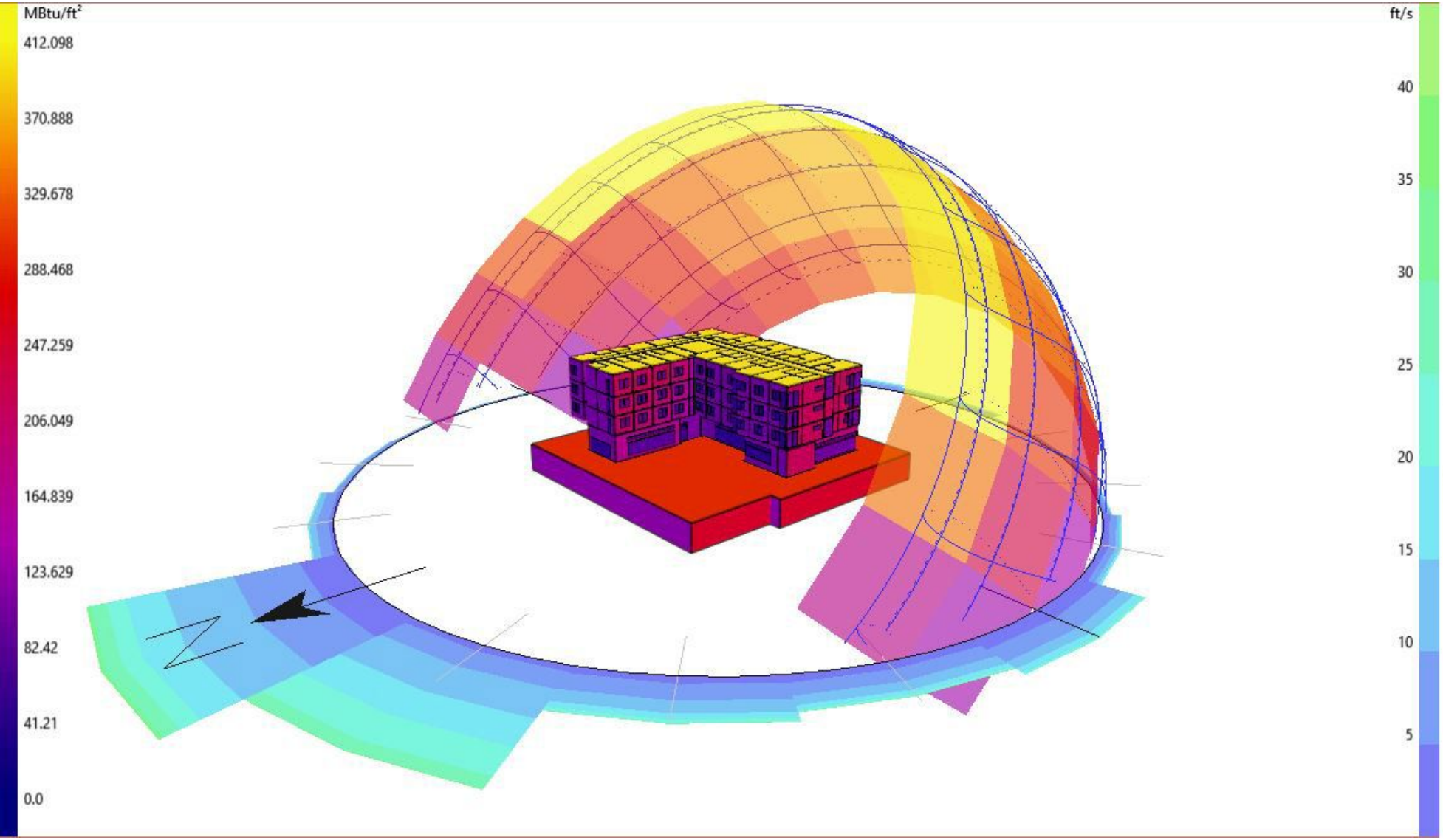
35% Skylight Glazing

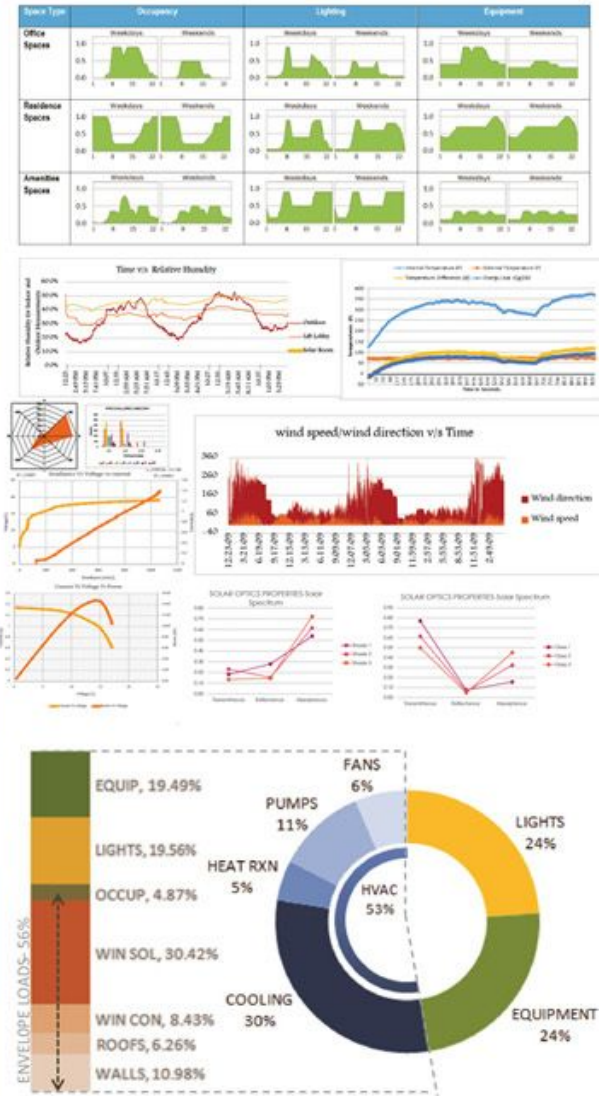


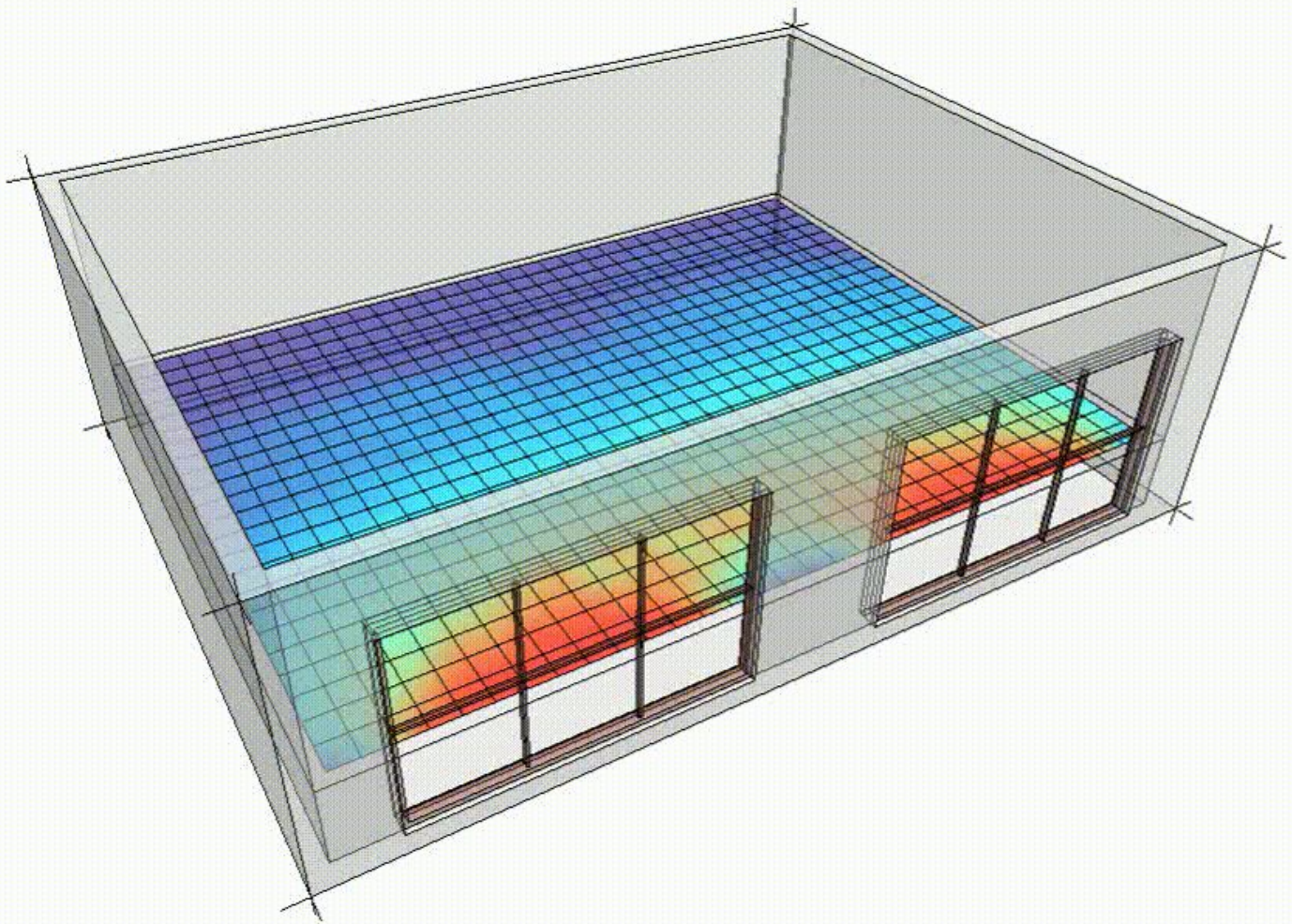
Efficiency Increase (Metric Tons /yr)

Elec. Consumption	-425 (6.2%)
Fuel Consumption	-418 (50.0%)

(Compared to 95% Skylight Glazing)


MBtu/ft²
412.098
370.888
329.678
288.468
247.259
206.049
164.839
123.629
82.42
41.21
0.0
ft/s
40
35
30
25
20
15
10
5


Space Type
Occupancy
Lighting
Equipment
Office Spaces
Residence Spaces
Amenities Spaces
Time v/s Relative Humidity
wind speed/wind direction v/s Time
Wind direction
Wind speed
ENVELOPE LOADS- 56%
EQUIP, 19.49%
LIGHTS, 19.56%
OCCUP, 4.87%
WIN SOL, 30.42%
WIN CON, 8.43%
ROOFS, 6.26%
WALLS, 10.98%
FANS 6%
PUMPS 11%
HEAT RXN 5%
HVAC 53%
COOLING 30%
LIGHTS 24%
EQUIPMENT 24%



66.15% sDA

Percentage Glazing

5 | 50 | 100

5 29 53 76 100

Number of Overhangs

0 | 8

0 2 4 6 8

Overhang Depth (ft)

0 | 6

0 1.5 3 4.5 6

Number of Fins

0 | 8

0 2 4 6 8

Fin Depth (ft)

0 | 6

0 1.5 3 4.5 6

Visible Transmittance (VT) %

0 | 65 | 100

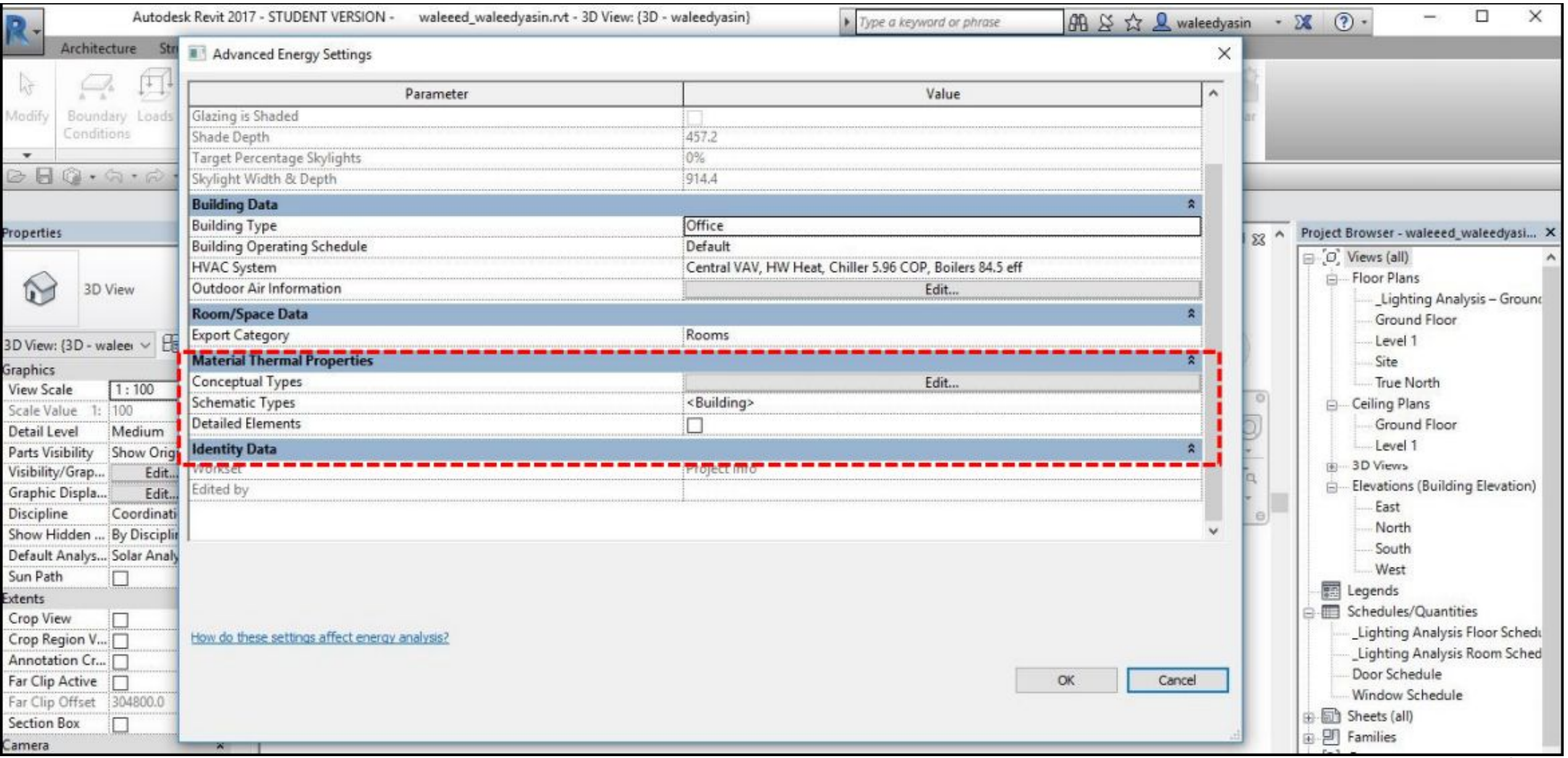
0 25 50 75 100

Add Obstruction

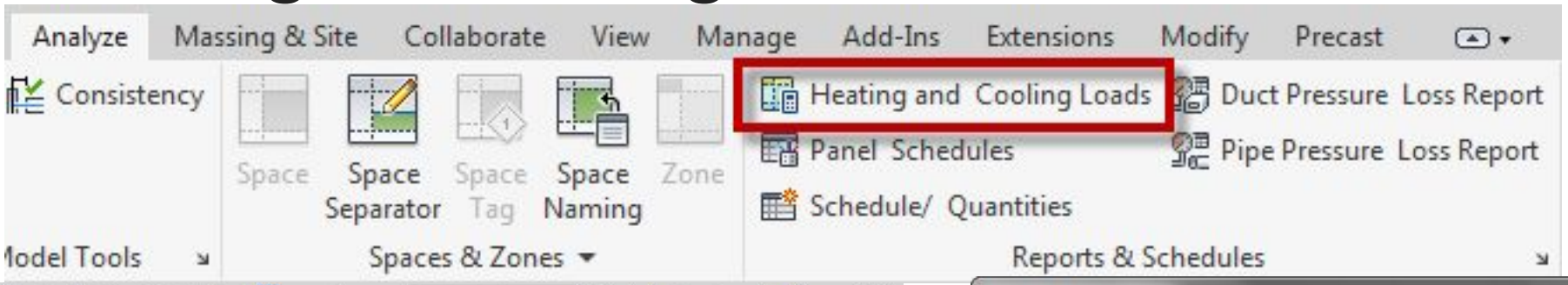
Distance to Obstruction (ft)

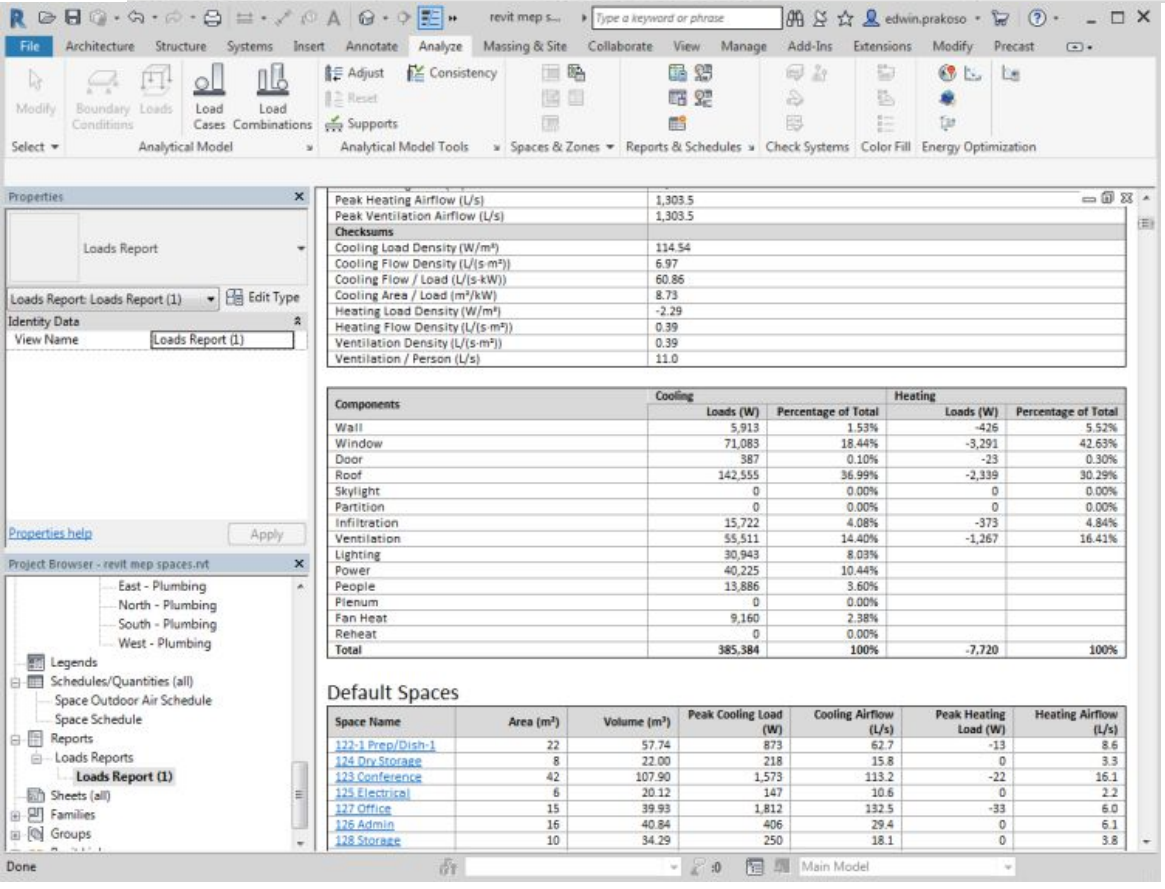
Height Of Obstruction (ft)

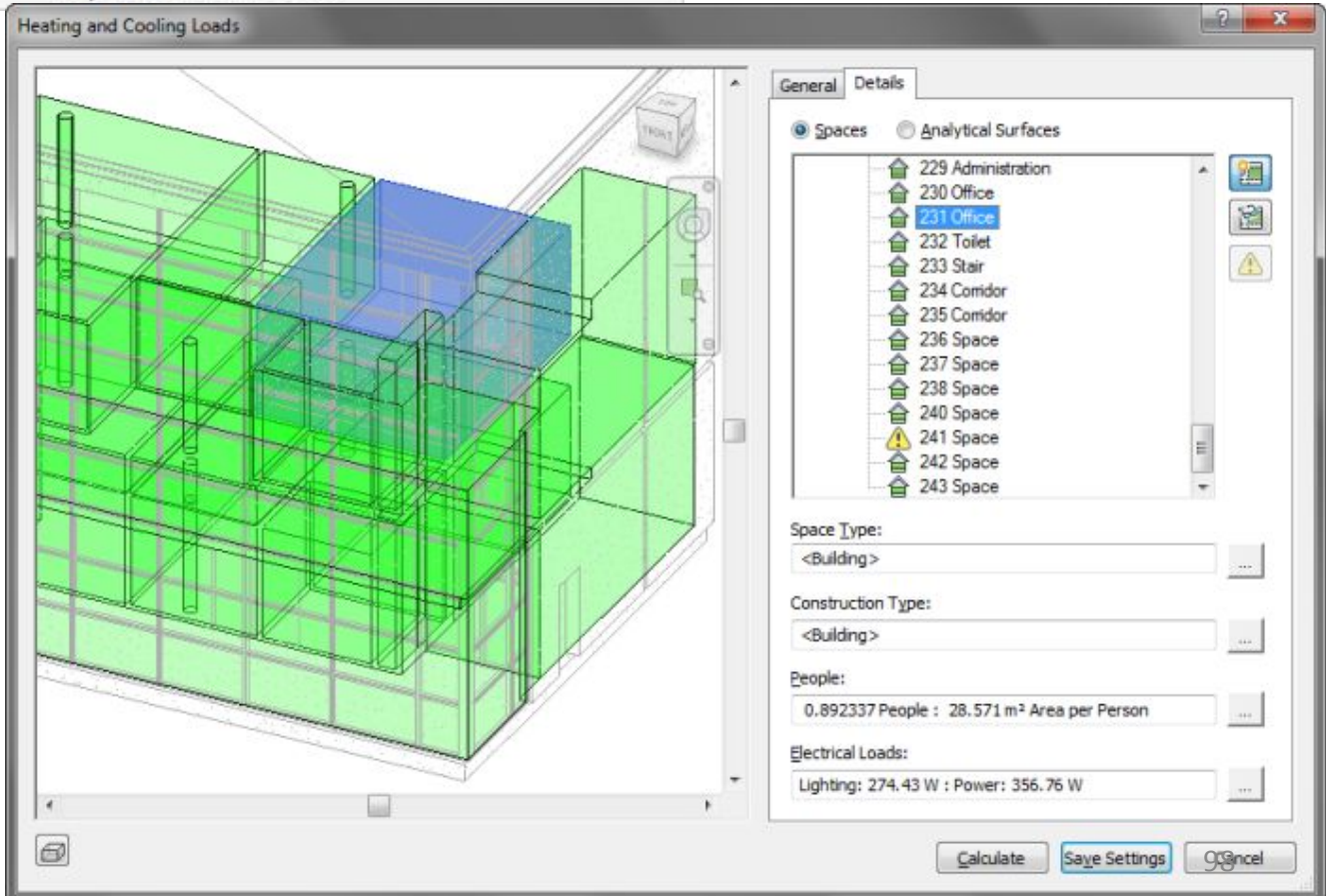
REVIT PRACTICE



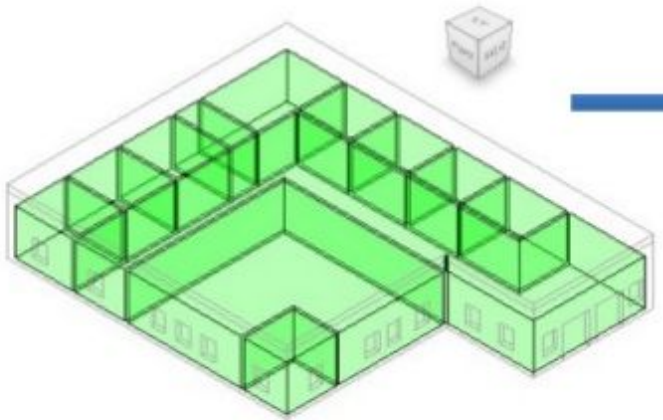
Heating and Cooling Load Calculation







4. Heating and Cooling Load Calculations



Heating and Cooling Loads

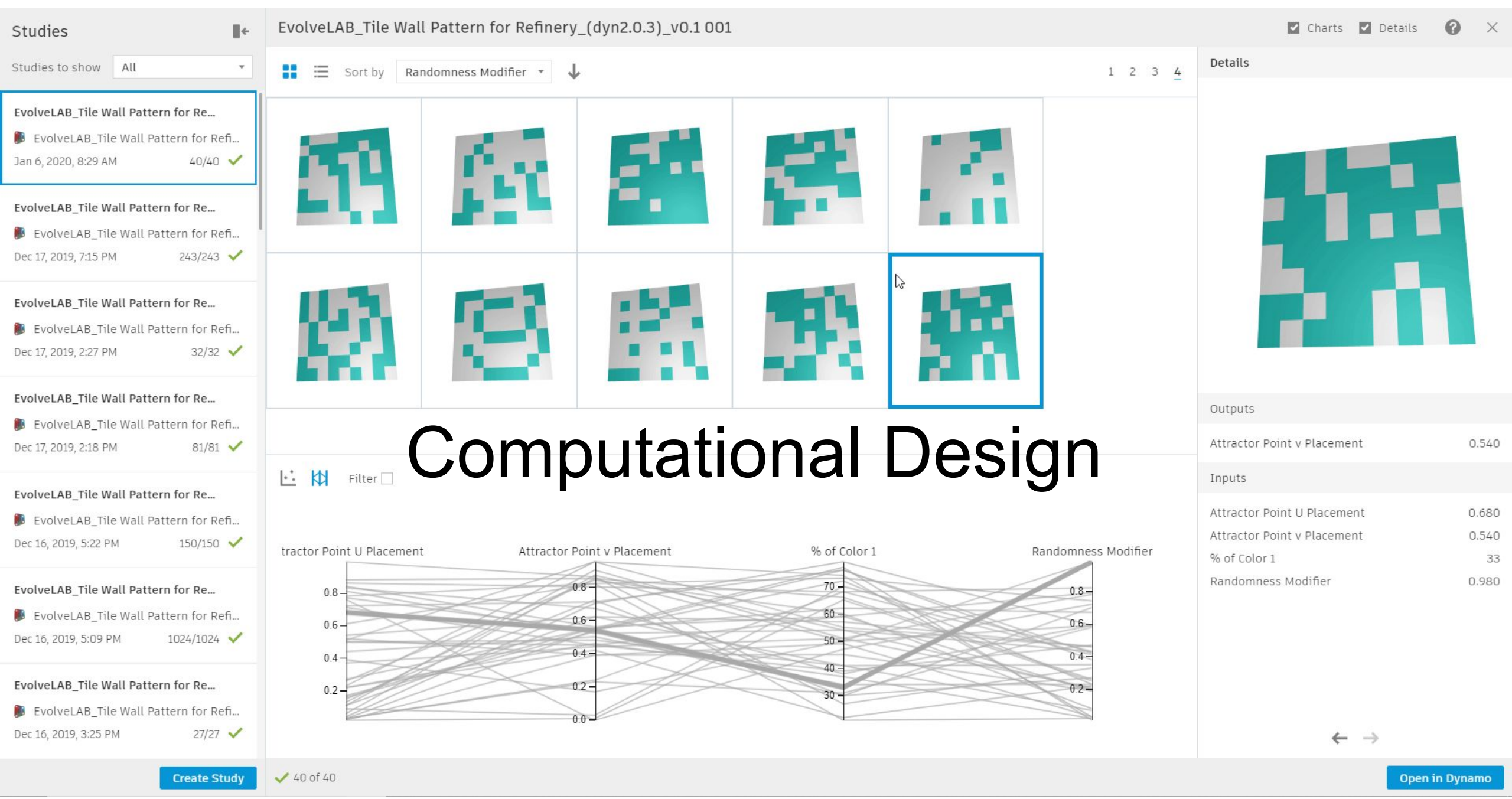
Parameter	Value
Building Type	Office
Location	Jeddah Saudi Arabia
Building Service	Constant Volume - Varia
Building Construction	<Building>
Building Infiltration Class	None
Report Type	Standard
Ground Plane	Level 1
Project Phase	New Construction
Sliver Space Tolerance	304.8
Use Load Credits	☐

Building Summary

Inputs	
Building Type	Office
Area (m²)	158
Volume (m³)	489.64
Calculated Results	
Peak Cooling Total Load (W)	**18,604**
Peak Cooling Month and Hour	July 2:00 PM
Peak Cooling Sensible Load (W)	17,194
Peak Cooling Latent Load (W)	1,411
Maximum Cooling Capacity (W)	18,604
Peak Cooling Airflow (L/s)	1,325.6
Peak Heating Load (W)	**2,390**
Peak Heating Airflow (L/s)	159.9
Checksums	
Cooling Load Density (W/m²)	117.79
Cooling Flow Density (L/(s·m²))	8.39
Cooling Flow / Load (L/(s·kW))	71.25
Cooling Area / Load (m²/kW)	8.49
Heating Load Density (W/m²)	15.13
Heating Flow Density (L/(s·m²))	1.01

Spaces

Space Name	Area (m²)	Volume (m³)	Peak Cooling Load (W)	Cooling Airflow (L/s)	Peak Heating Load (W)	Heating Airflow (L/s)
1 Common	56	174.15	3,544	259.5	703	47.0
2 Office 1	7	20.92	1,014	74.3	157	10.5
3 Office 2	7	23.25	960	70.3	121	8.1
4 Office 3	7	22.48	930	68.1	117	7.8
5 Office 4	8	23.81	982	71.9	124	8.3
7 Office 7	7	22.61	1,055	77.2	165	11.0
8 Office 6	8	24.27	1,007	73.7	119	8.0
9 Washroom	6	19.78	721	52.8	96	6.4
10 Office 5	13	41.35	1,792	131.2	248	16.6
11 Department Manager	4	12.37	471	34.5	115	7.7
12 Department	34	104.64	5,623	411.8	425	28.5



Computational Design

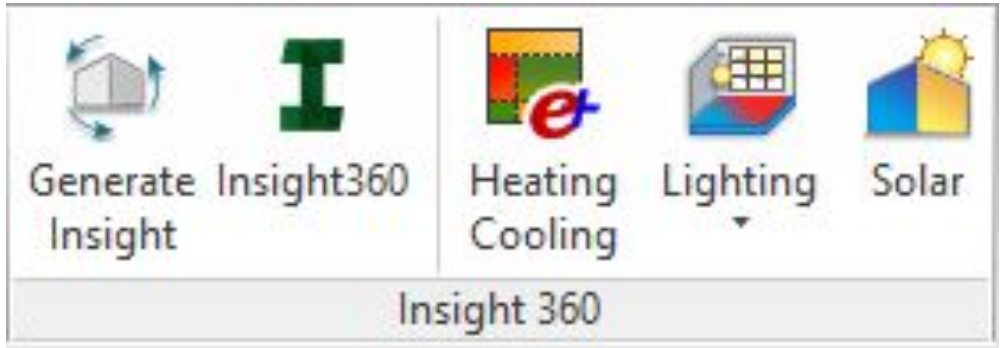
Software

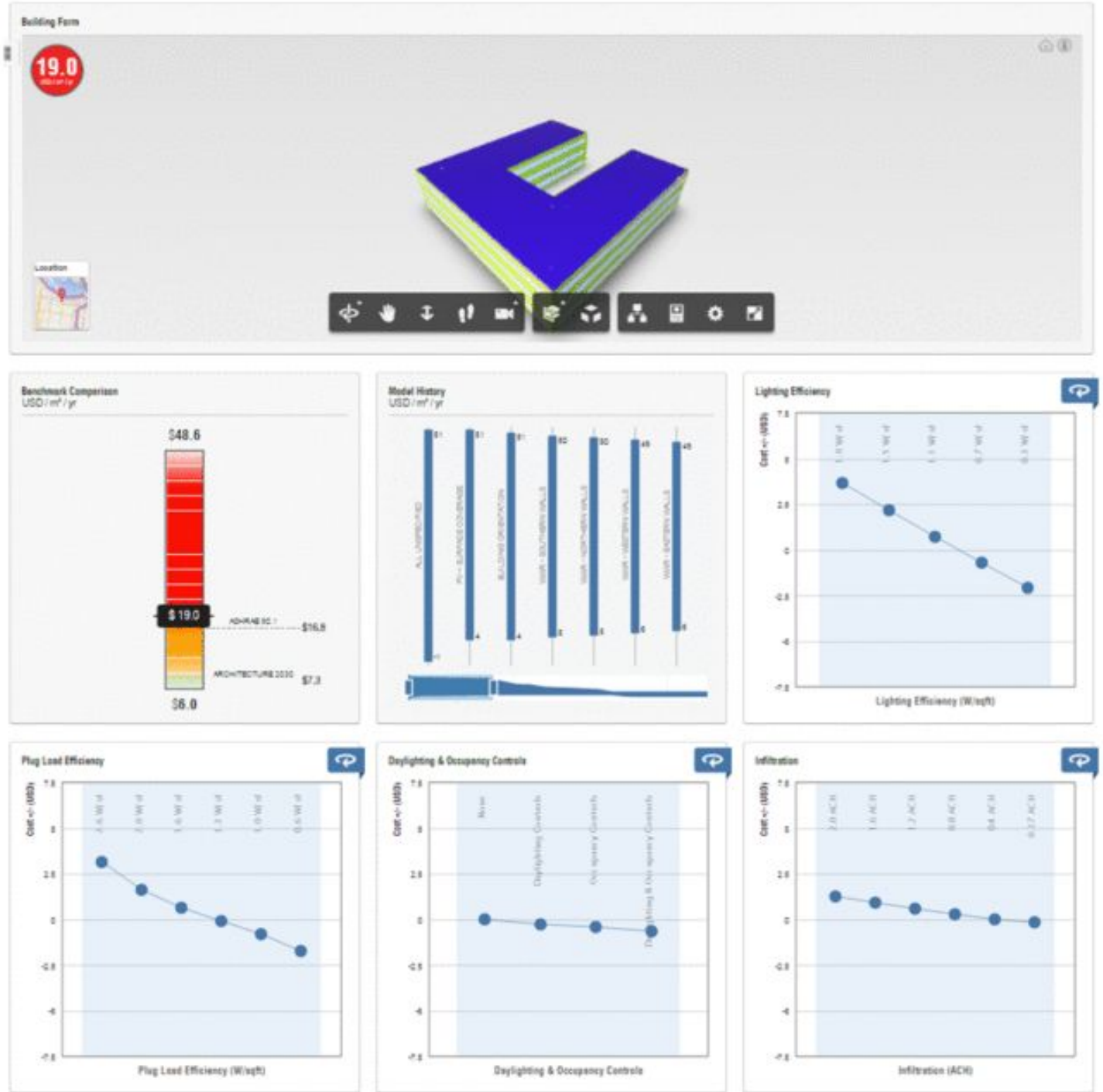
External to Revit

- Insight 360

New cloud-based tool enabling a new way to experience building energy and environmental performance and the collective actions that lead to better outcomes throughout all stages of the building lifecycle.

https://insight.autodesk.com/OneEnergy/Model/128869






Perform sun and shadow studies

Software

Insight 360

- Solar Analysis

Visualize and quantify the distribution of solar radiation on various surfaces.

- Light Analysis

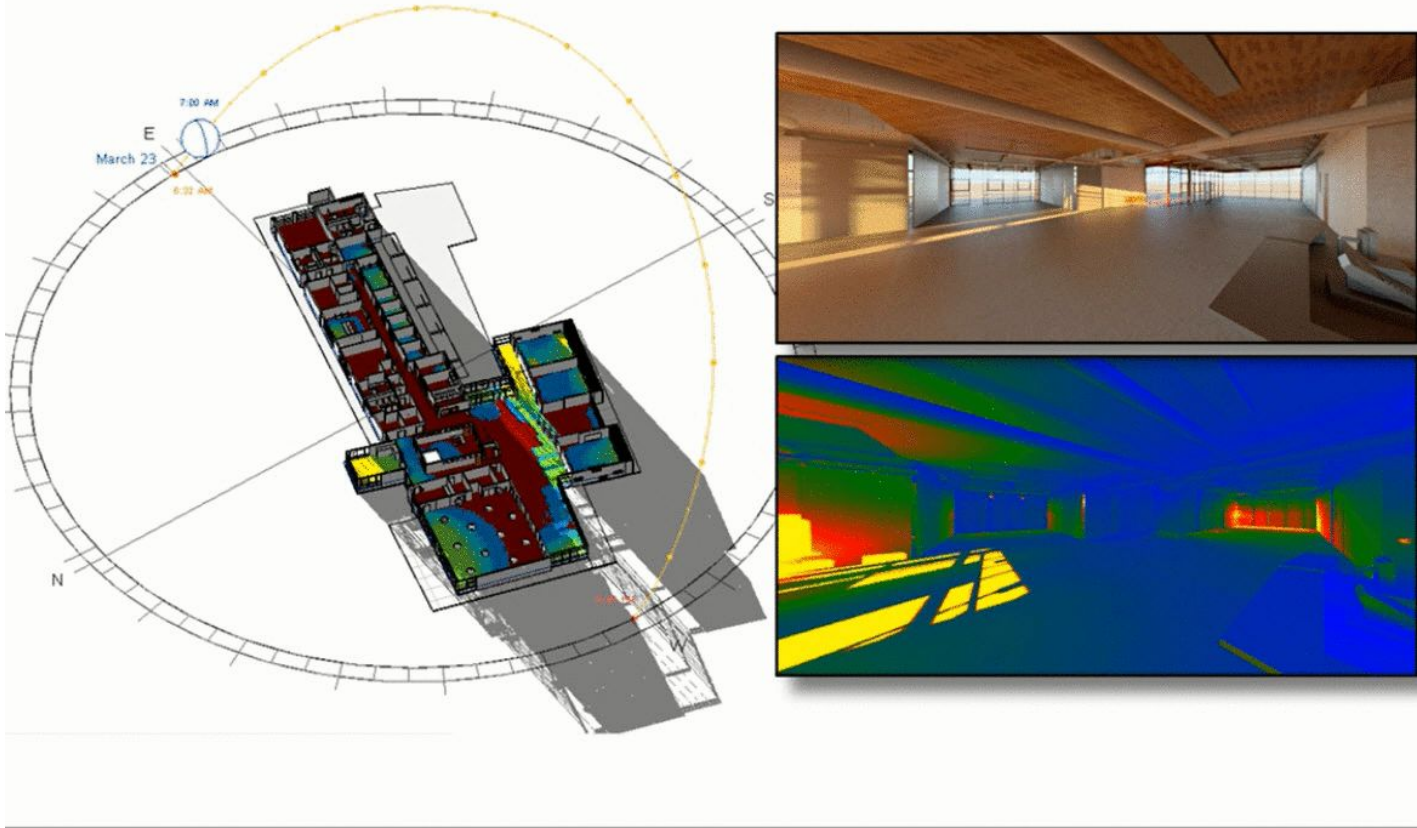
Analysis for illuminance and validation for LEED v3 IEQc8.1 and LEED v4 IEQ Daylight Credit, Option 2.

- Heating and Cooling Loads

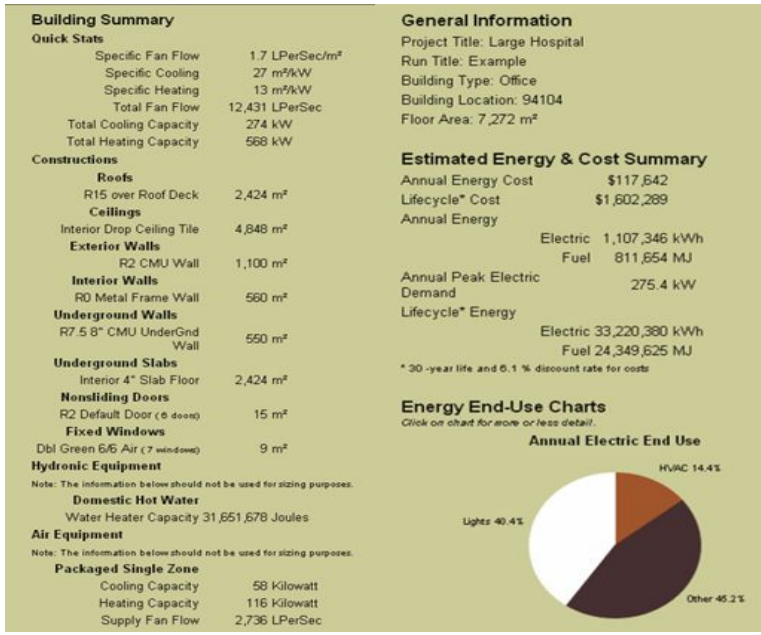
Tool used primarily by mechanical engineers to size HVAC equipment.

- Generate Insight

Automatically varies building design inputs resulting in high and low possible annual energy costs with approximately +/- 10% accuracy. Inputs can then be adjusted, e.g., glazing properties, to see instant feedback on performance impacts.



External to Revit



Building Summary

Quick Stats

Specific Fan Flow	1.7 LPerSec/m²
Specific Cooling	27 m²/kW
Specific Heating	13 m²/kW
Total Fan Flow	12,431 LPerSec
Total Cooling Capacity	274 kW
Total Heating Capacity	568 kW

Constructions

Roofs	
R15 over Roof Deck	2,424 m²
Ceilings	
Interior Drop Ceiling Tile	4,848 m²
Exterior Walls	
R2 CMU Wall	1,100 m²
Interior Walls	
R0 Metal Frame Wall	560 m²
Underground Walls	
R7.5 8" CMU UnderGnd Wall	550 m²
Underground Slabs	
Interior 4" Slab Floor	2,424 m²
Nonsliding Doors	
R2 Default Door (6 doors)	15 m²
Fixed Windows	
Dbl Green 6/6 Air (7 windows)	9 m²

Hydronic Equipment

Note: The information below should not be used for sizing purposes.

Domestic Hot Water	
Water Heater Capacity	31,651,678 Joules

Air Equipment

Note: The information below should not be used for sizing purposes.

Packaged Single Zone	
Cooling Capacity	58 Kilowatt
Heating Capacity	116 Kilowatt
Supply Fan Flow	2,736 LPerSec

General Information

Project Title: Large Hospital
Run Title: Example
Building Type: Office
Building Location: 94104
Floor Area: 7,272 m²

Estimated Energy & Cost Summary

Annual Energy Cost	$117,642
Lifecycle* Cost	$1,602,289
Annual Energy	
Electric	1,107,346 kWh
Fuel	811,654 MJ
Annual Peak Electric Demand	275.4 kW
Lifecycle* Energy	
Electric	33,220,380 kWh
Fuel	24,349,625 MJ

* 30 -year life and 6.1 % discount rate for costs

Energy End-Use Charts

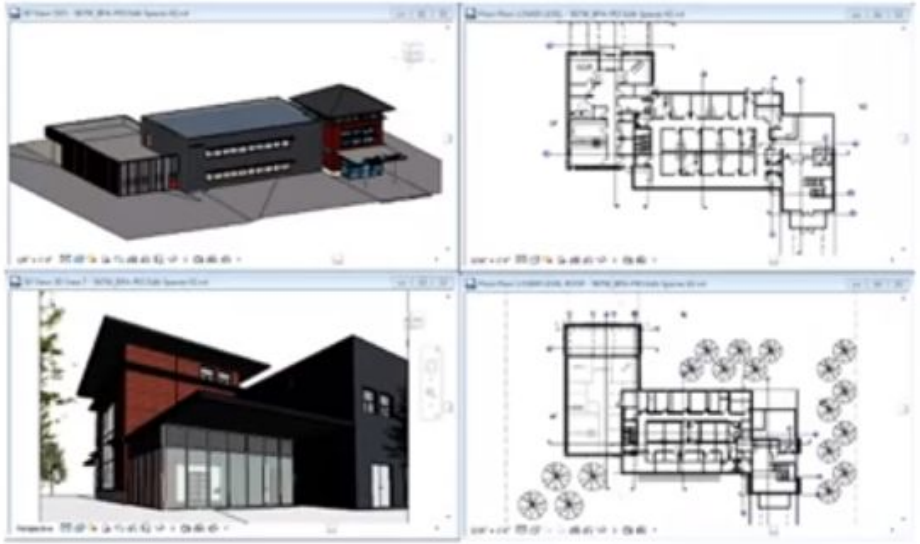
Click on chart for more or less detail.

Annual Electric End Use

- Green Building Studio (GBS)
- Standalone cloud-based whole building performance analysis using the DOE2 simulation engine.
- Web-based solution
- Early building energy design decisions
- Whole building energy analysis
- Design alternative comparisons
- https://gbs.autodesk.com/GBS/Project

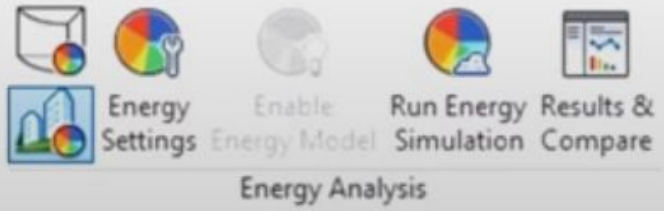
Climate Analysis using Autodesk Green Building Studio

Step 1 :-Create the Revit building model.



Step 2:- To use this feature, you must sign in to Autodesk 360

Step 3:- Set building elements as the basis for the energy simulation.



Step 4:-Specify the building energy settings as needed

Step 5:- Run the Energy Simulation.

Output:

- Customizable charts for
  - Heating Loads
  - Cooling Loads
  - Estimated Energy End Use
  - Energy Cost
  - Dry Bulb Temperature
  - Wind Data
- Customizable Parametric Studies
- Annual carbon footprint specific to region and utility mix
- Renewable energy potential (photovoltaic and wind)
- Weather data summary and user defined graphics
- Building and site specific natural ventilation potential
- US EPA ENERGY STAR
- Water preliminary analysis for LEED
- Building summary of construction areas, equipment capacities, etc.
- gbXML file for import to Trane TRACE 700 or other gbXML-compliant tools
- DOE-2.2 file for import to eQUEST
- EnergyPlus IDF file for editing and running in EnergyPlus
- VRML file
- Design Review file

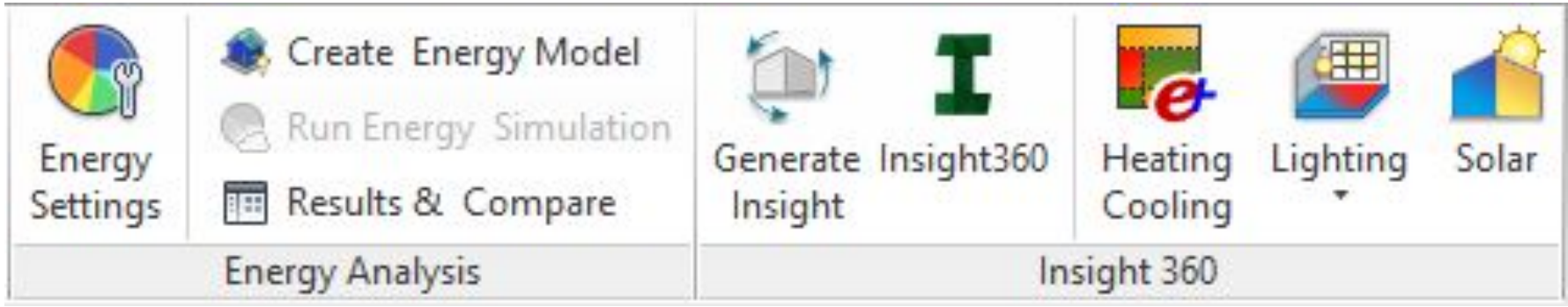
Within Revit

- Energy Analysis

Analyze a design's expected energy use based on geometry and location on earth.

Energy Settings dialog (**Analysis** tab)

- Set Location
- Select Project Phase
- Specify **Analysis Mode:** Avoid *Use Conceptual Masses* setting)
- All other settings are optional

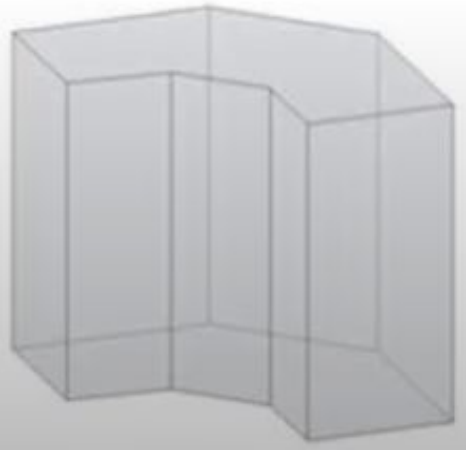


Energy Analysis tools on the Analysis tab in Revit 2016 R2, plus the Insight 360 add-in.

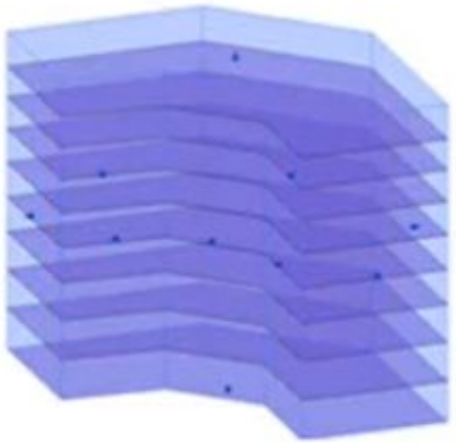
Steps for Performing Conceptual Energy Analysis

Step 1:- To use this feature, you must sign in to Autodesk 360

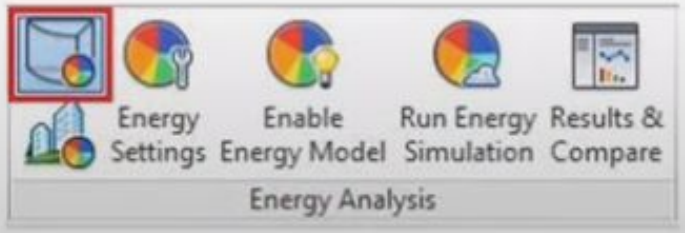
Step 2:-Create a mass model.



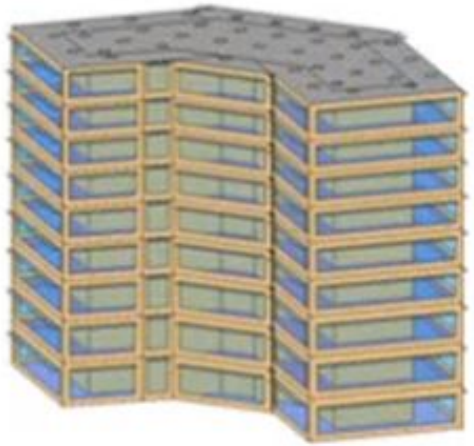
Step 3:- Add mass floors.



Step 4:- Set conceptual masses as the basis for the energy simulation.



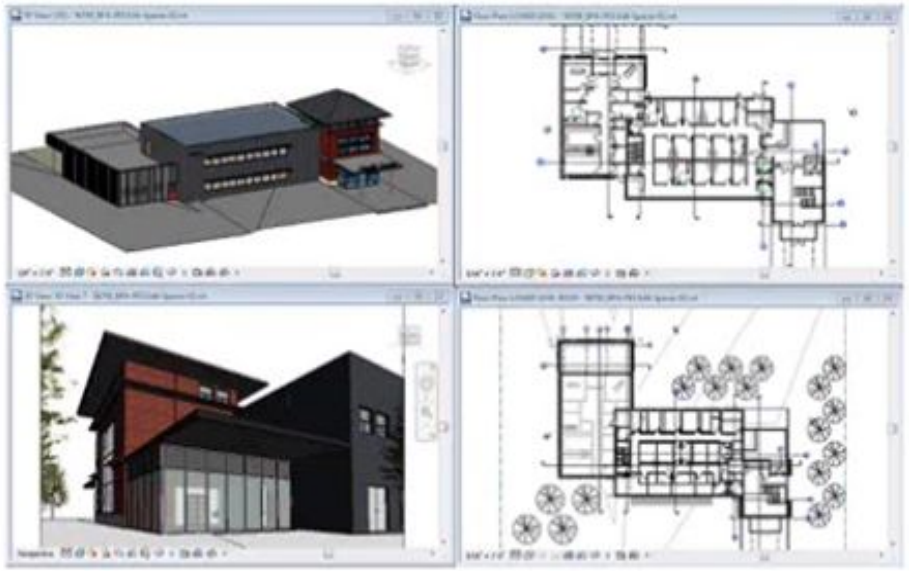
Step 5:- Create the energy model



Step 6:- Run the Energy Simulation.

Steps for Performing Energy Analysis using Building Elements

Step 1 :-Create the Revit building model.

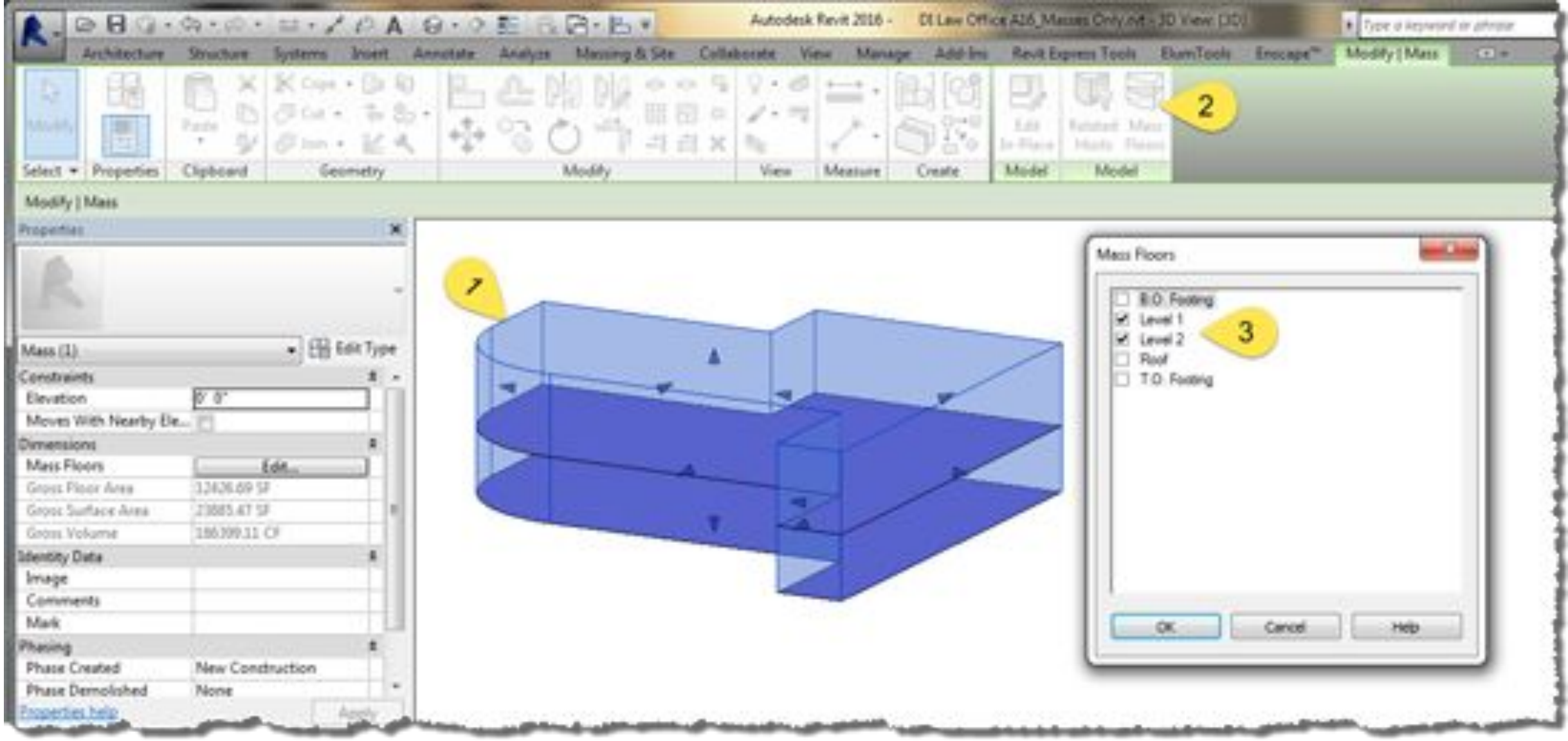


Step 2:- To use this feature, you must sign in to Autodesk 360

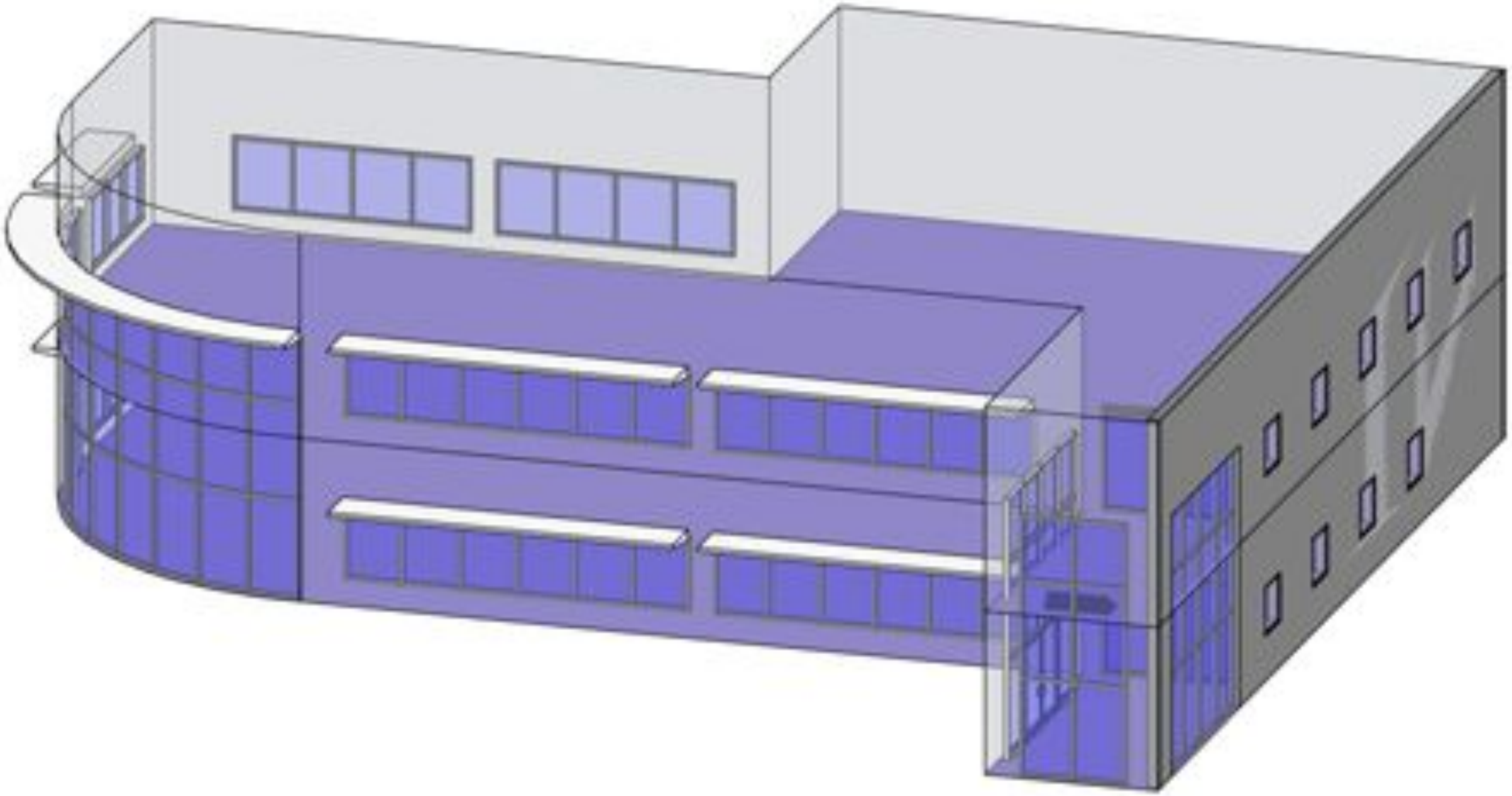
Step 5:- Run the Energy Simulation.

Step 3:- Set building elements as the basis for the energy simulation.

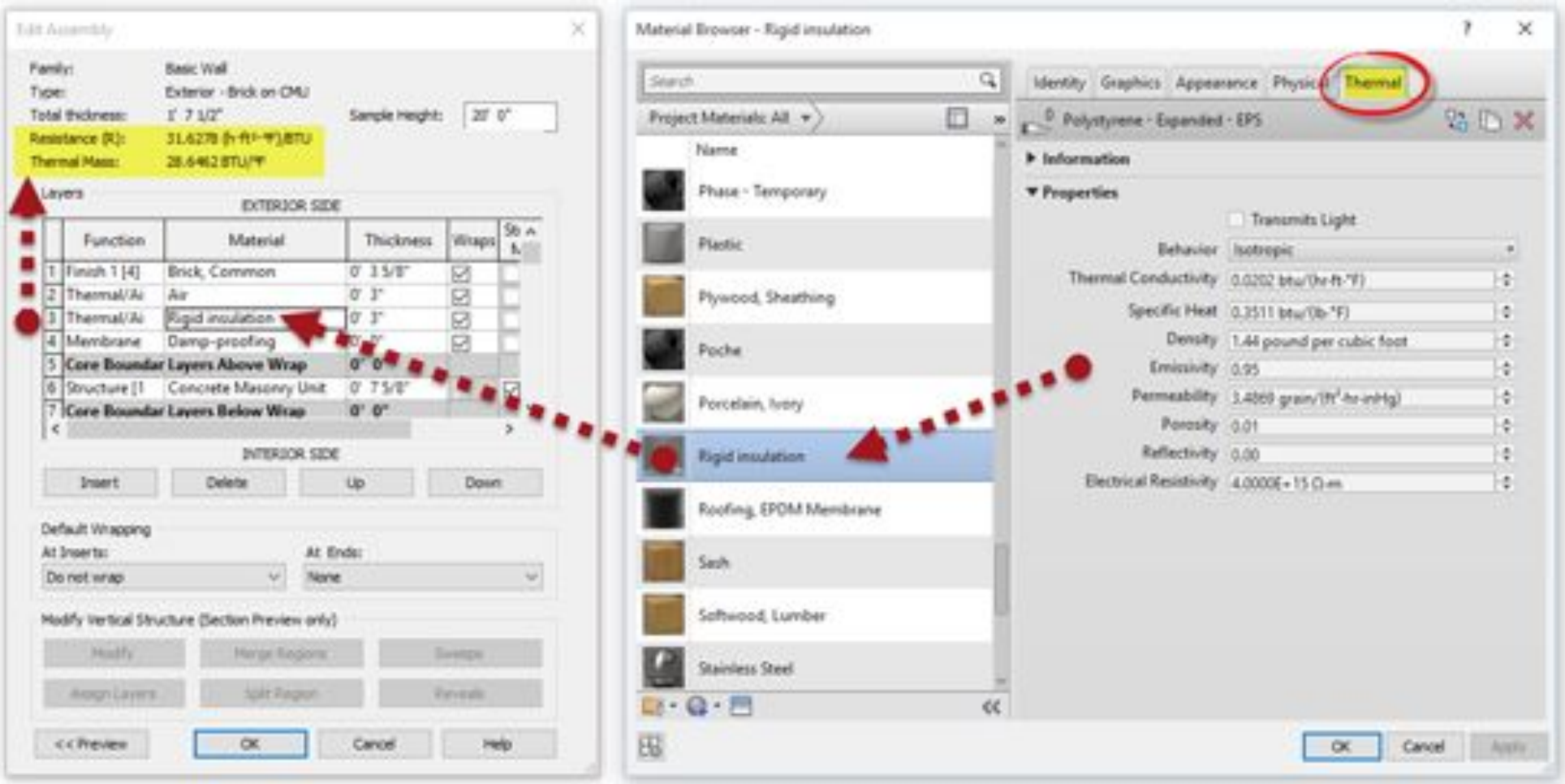
Step 4:-Specify the building energy settings as needed



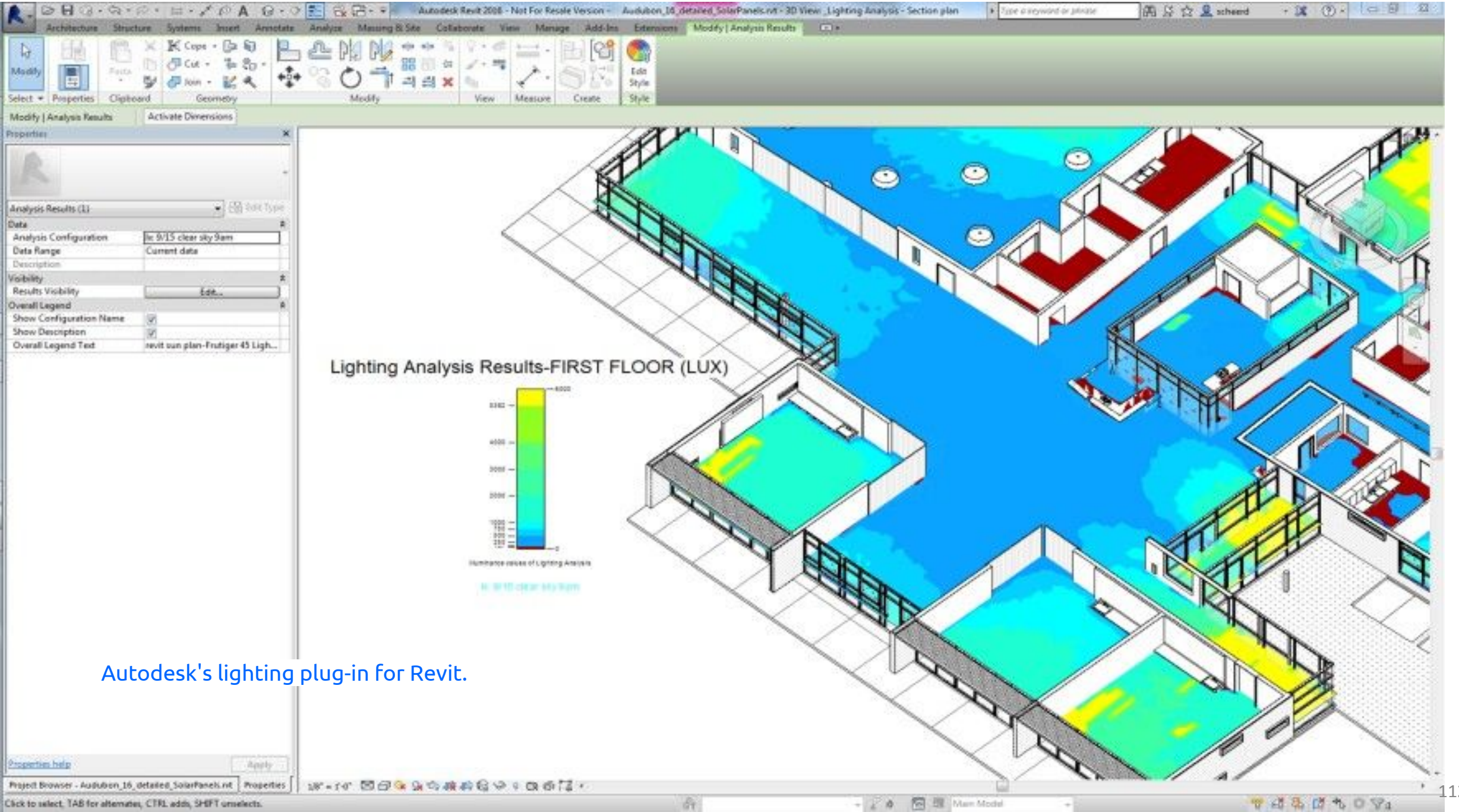
Masses must have ‘mass floors’ specified to create a valid EAM.



Masses and Building Elements used together in energy analysis.

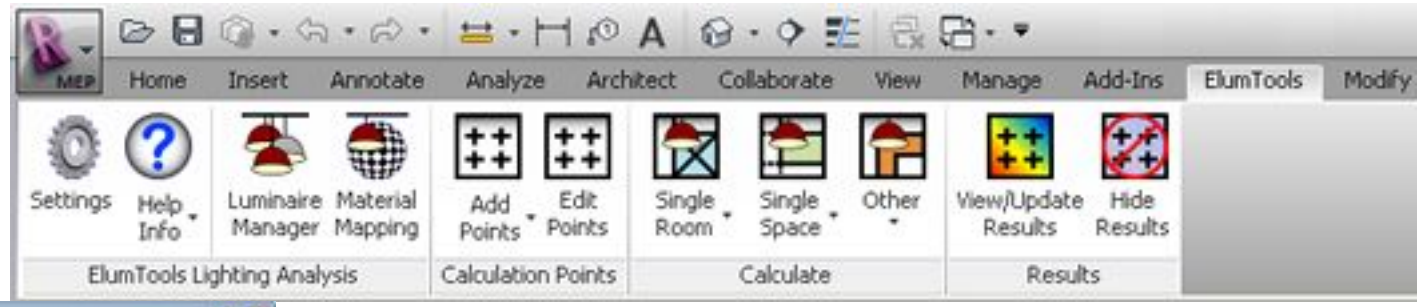


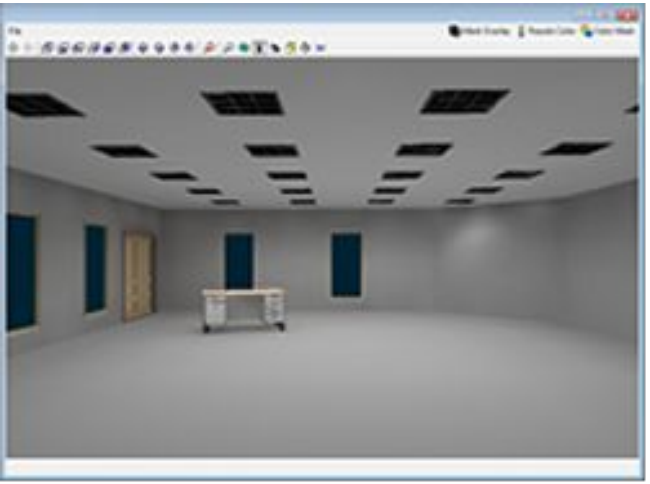
Thermal properties associated with building elements can be used in the energy simulation.

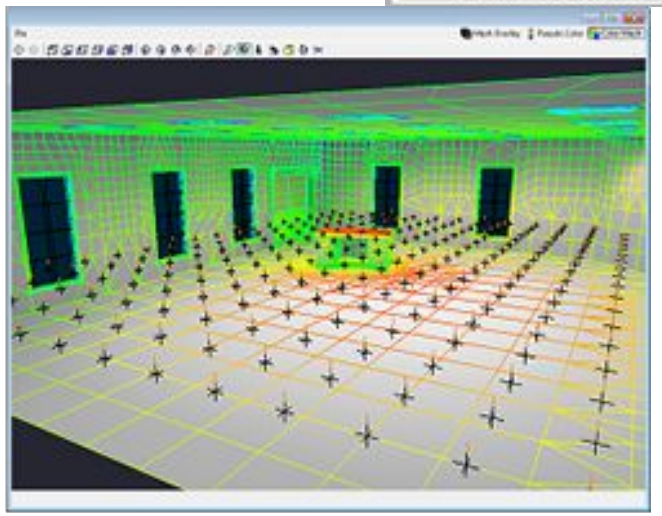


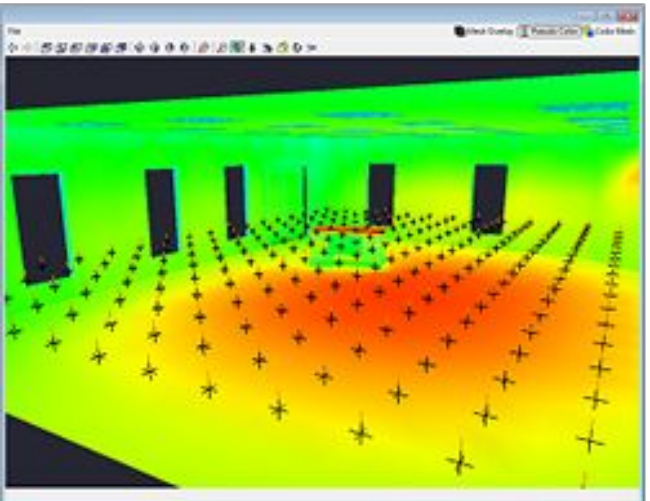
Autodesk's lighting plug-in for Revit.

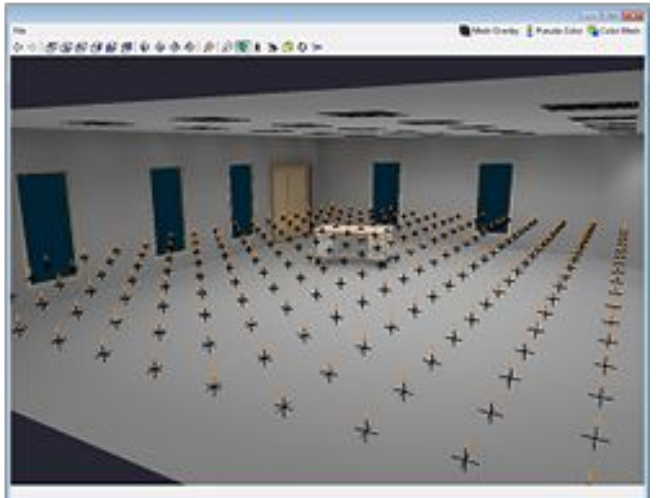
ElumTools

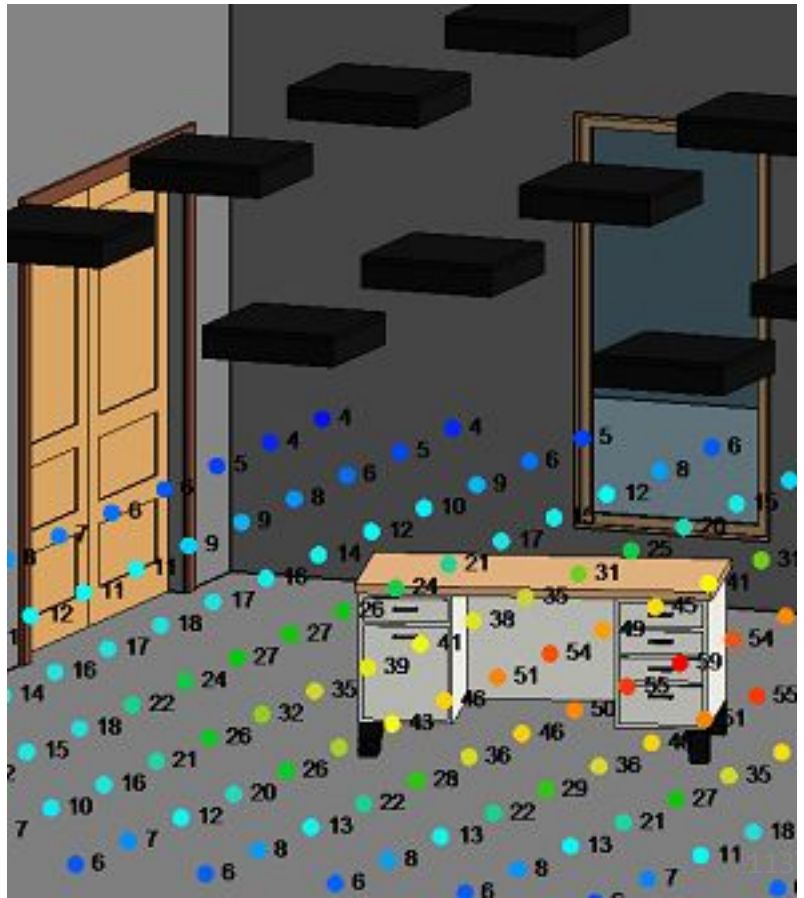

MEP
Home
Insert
Annotate
Analyze
Architect
Collaborate
View
Manage
Add-Ins
ElumTools
Modify
Settings
Help Info
Luminaire Manager
Material Mapping
Add Points
Edit Points
Single Room
Single Space
Other
View/Update Results
Hide Results
ElumTools Lighting Analysis
Calculation Points
Calculate
Results









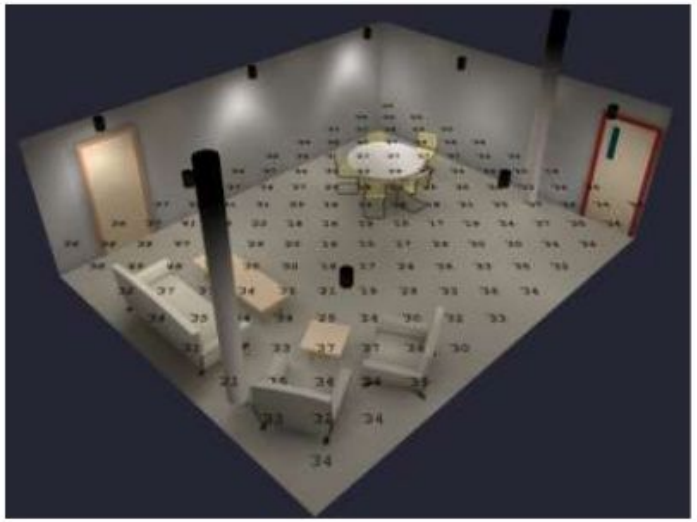


Artificial lighting

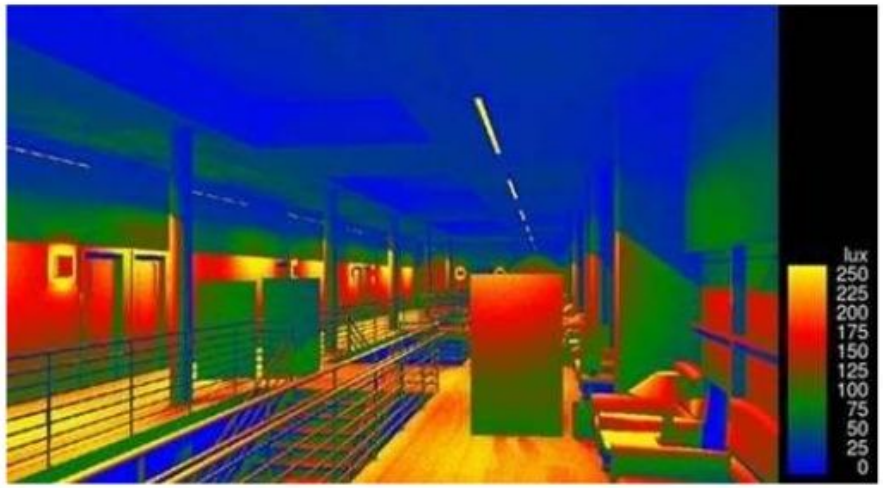
The simulations allow to calculate a series of climate-based daylight metrics such as:

- **Daylight Autonomy (DA)**
- **Useful Daylight Illuminance (UDI)**
- **Daylight Glare Probability (DGP)**
- **Daylight Factor (DF)**

Lighting Analysis

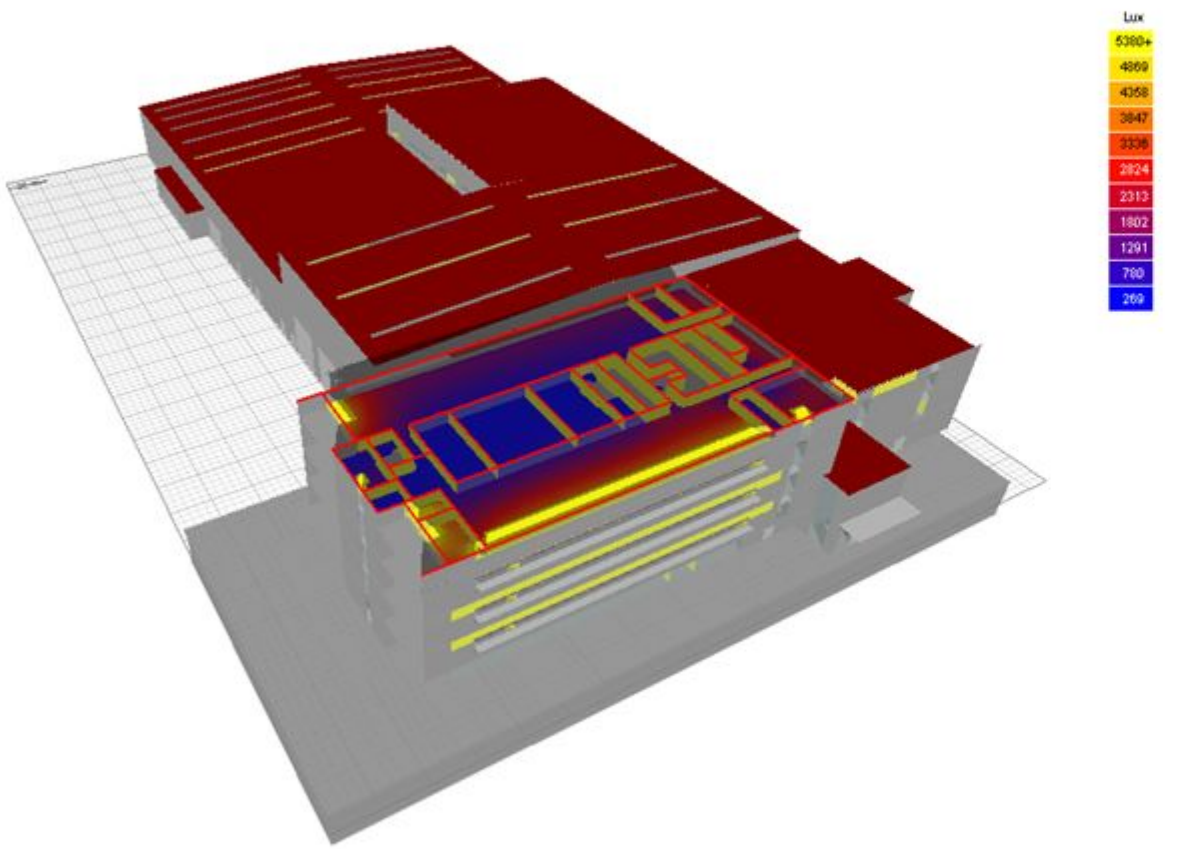


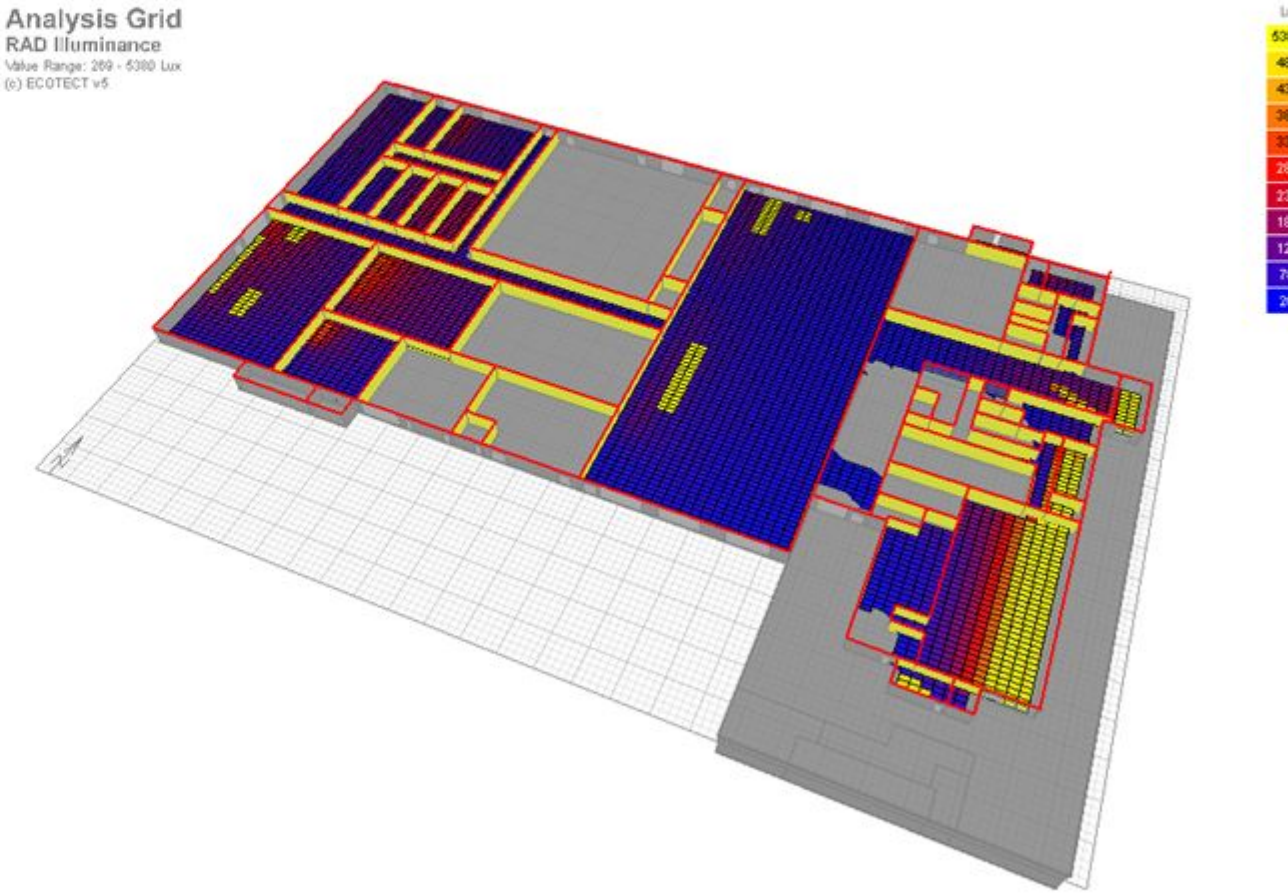
ElumTools in Revit
Calculate Point by Point



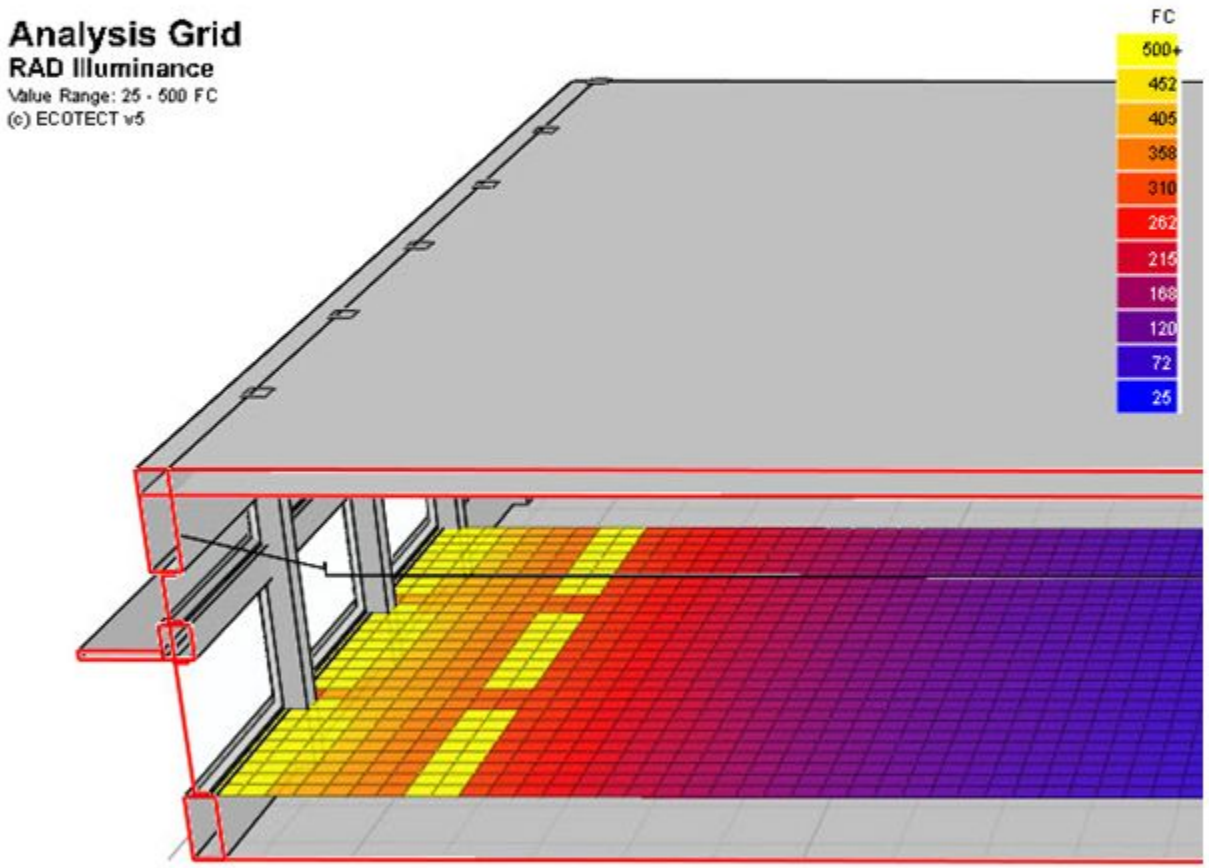
Illuminance Study
Light Distribution and Glare

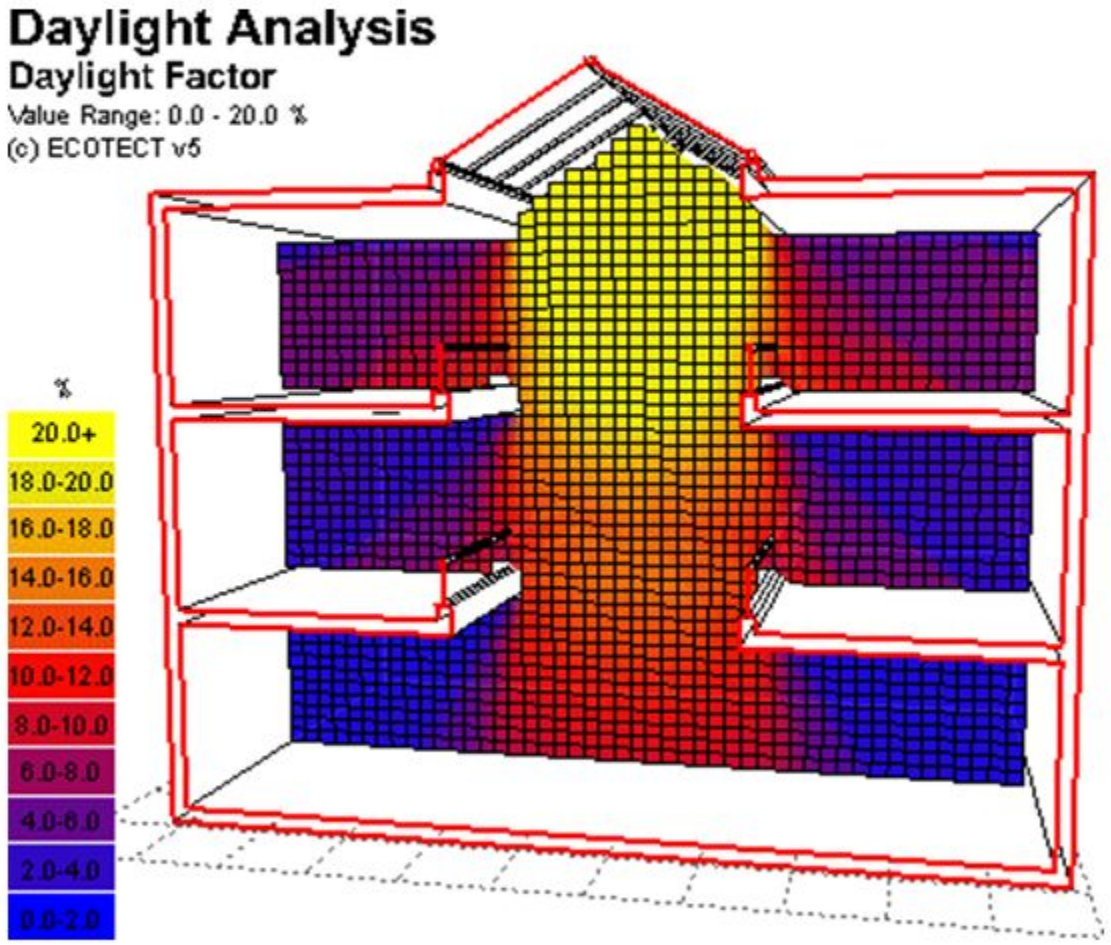
Daylighting Modeling -3D View





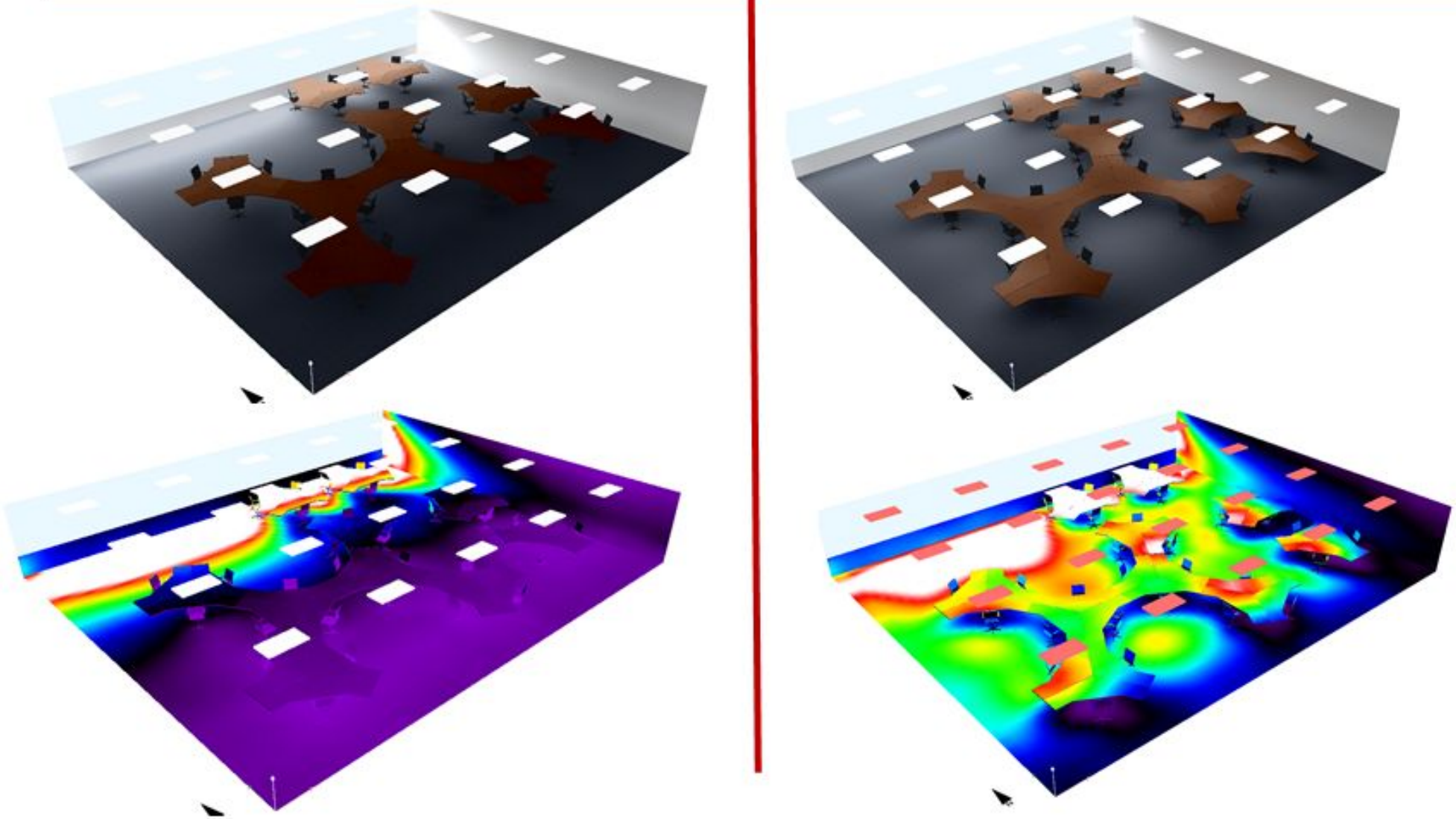
Daylighting simulation extract





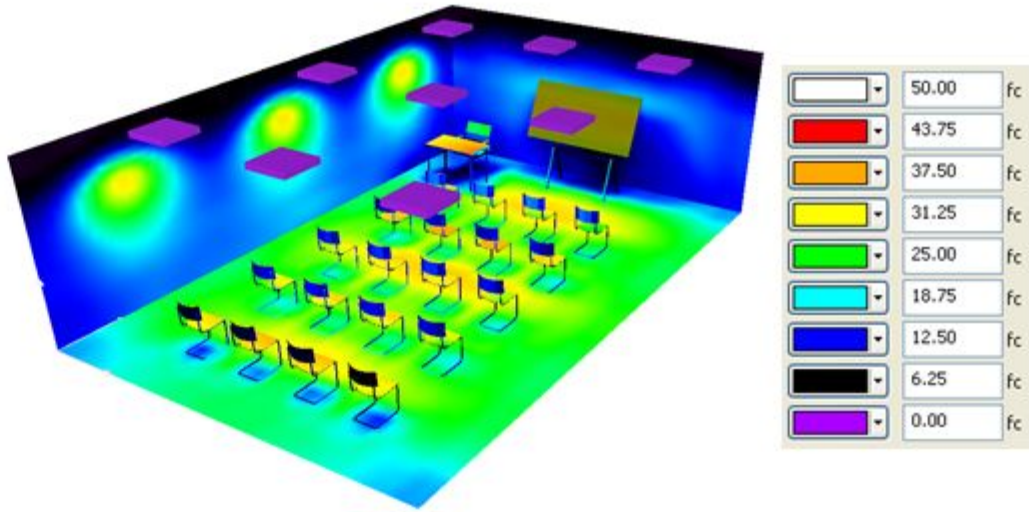
North-facing window

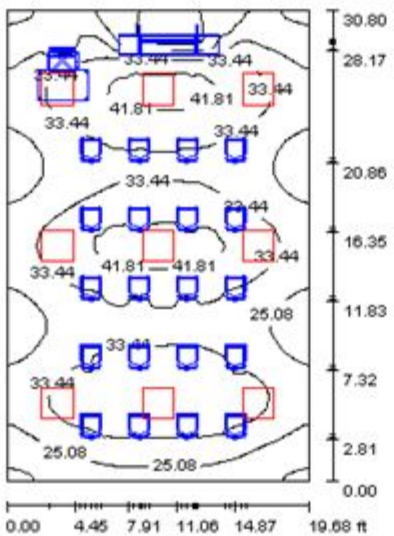
North-facing window + **skylight** (about 20m^2)



→Recommend to install skylight above regularly occupied spaces in the office 2nd floor

Training Room Lighting

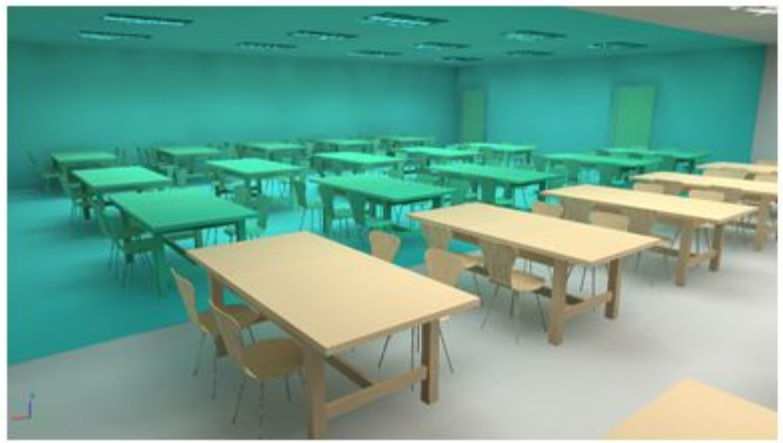


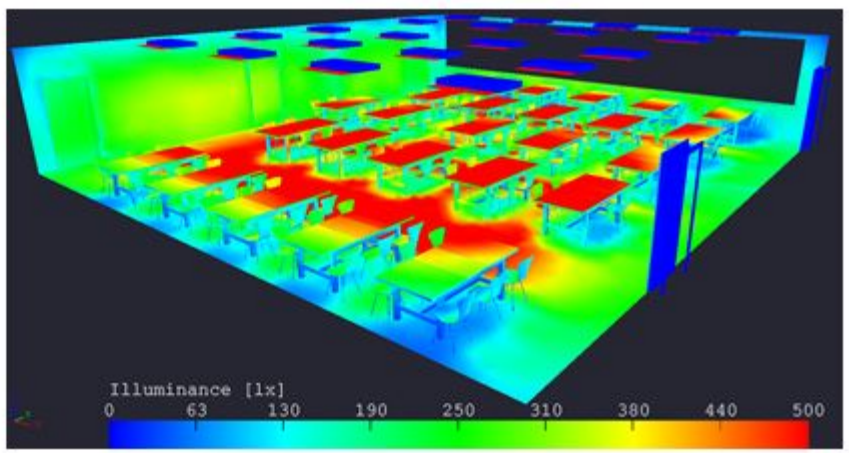


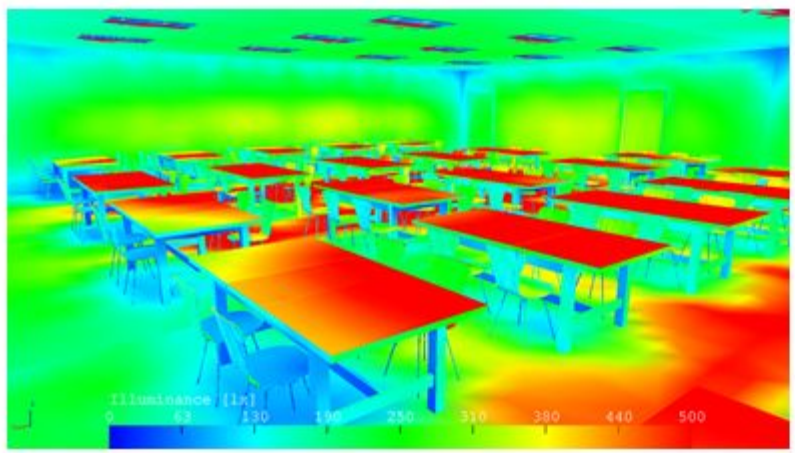
Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3x14 W	9	432	330

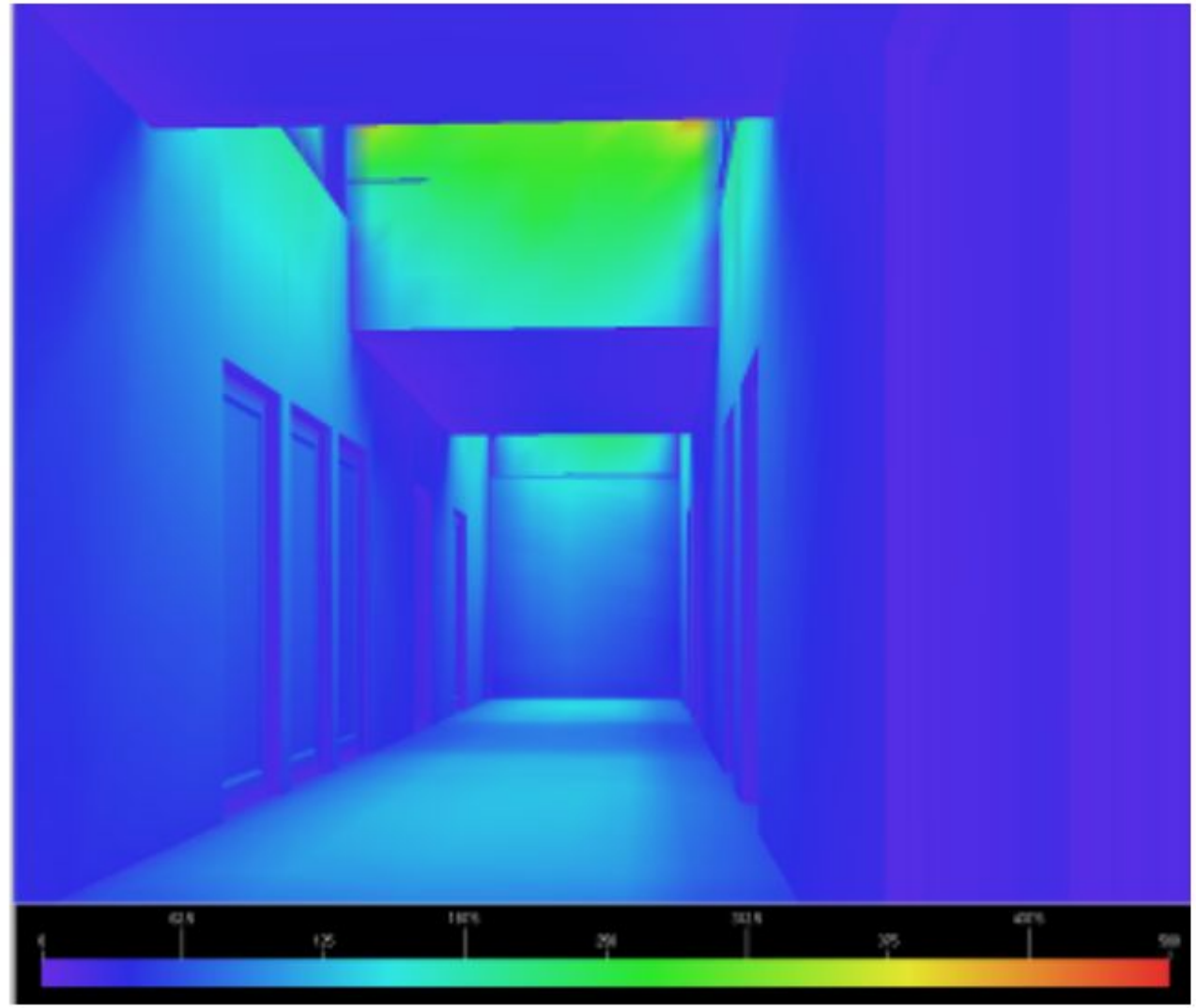
→ Installed LPD = **7.6 W/m²**

Canteen Lighting

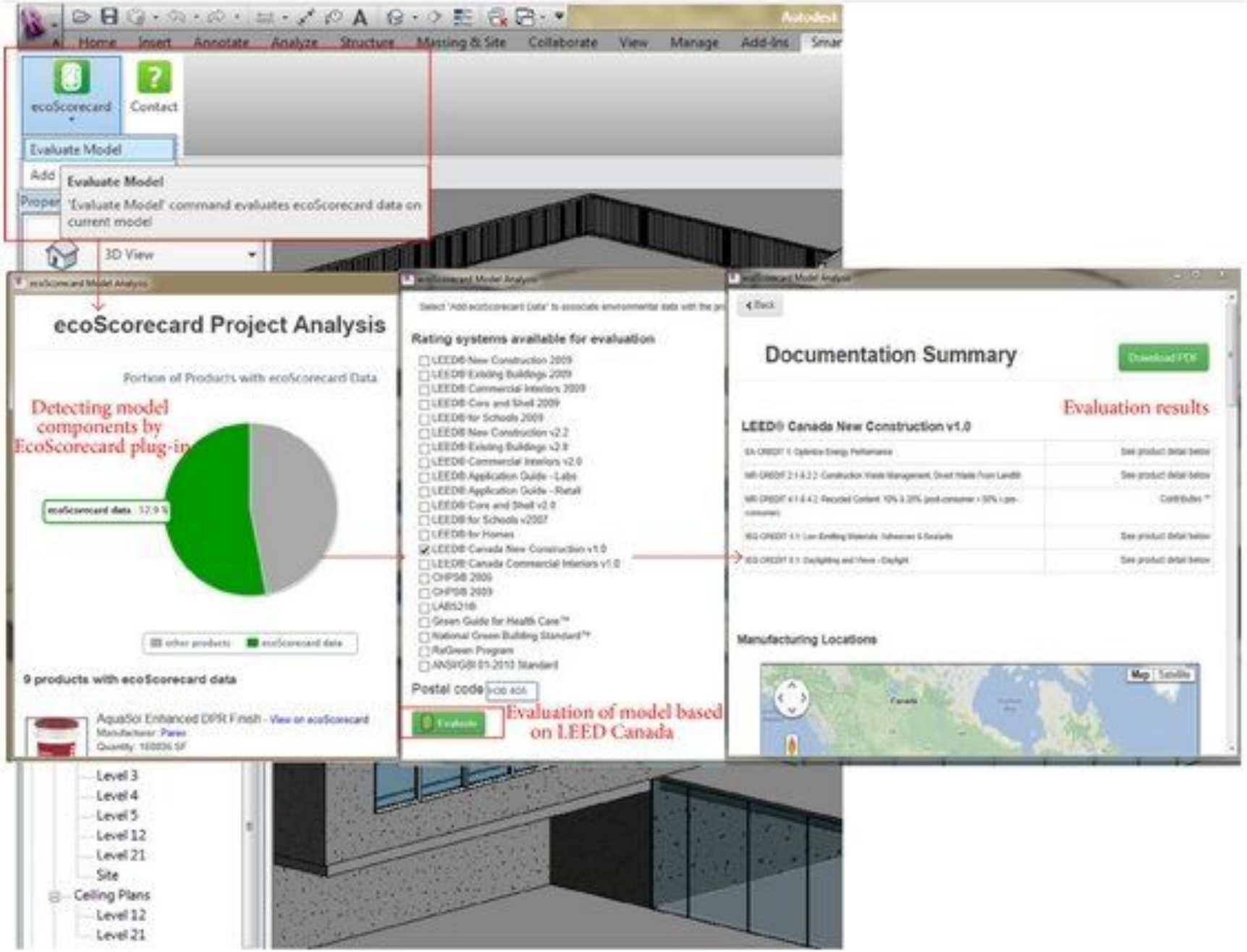








Eco Score card plug-in



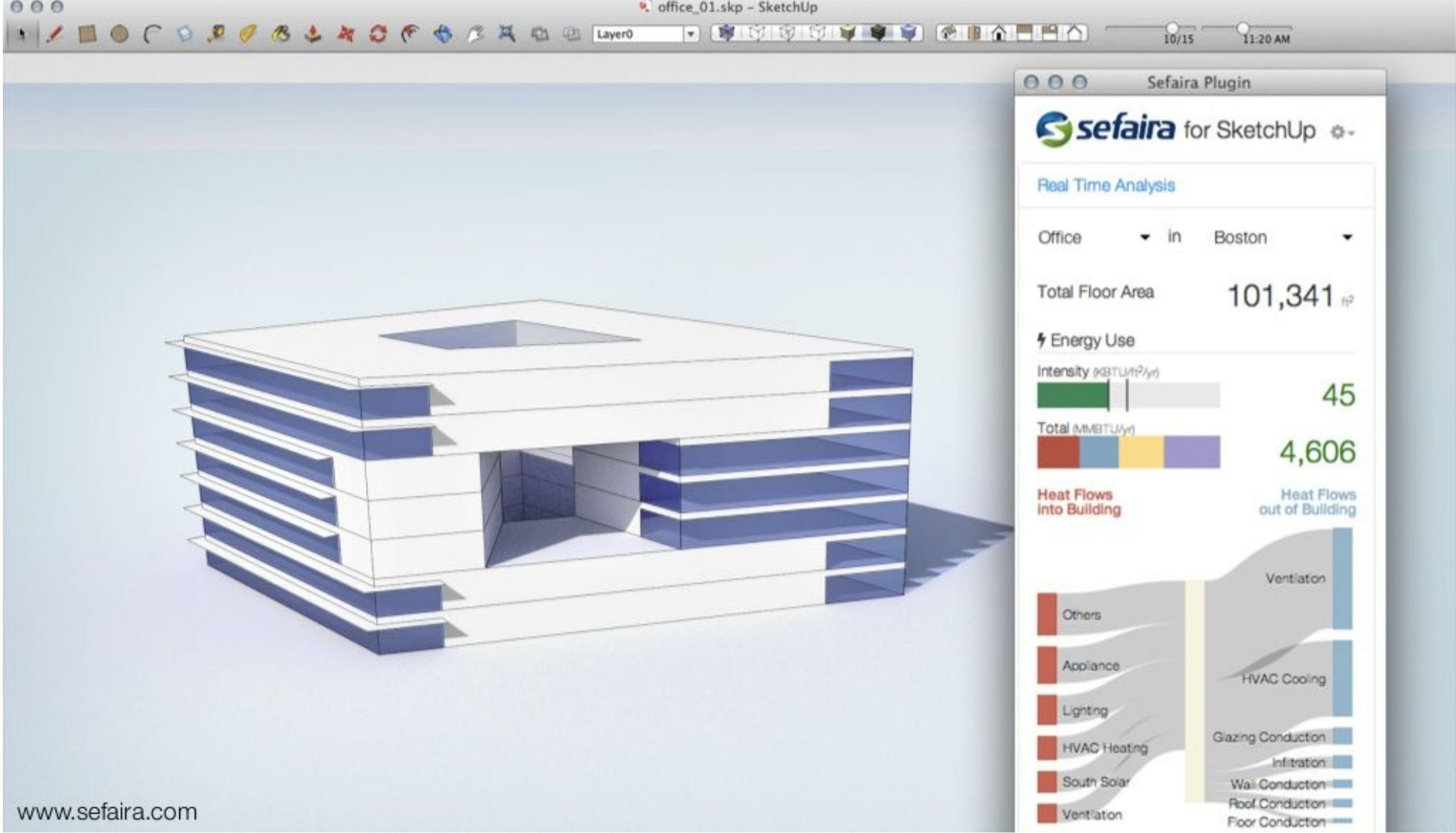
Energy Simulation Plug-ins for Revit

- Energy simulation plug-ins available for Revit:

IES-VE, Design Builder and Sefaira.

- IES and Design Builder are 2 standalone energy simulation software famous among energy modelers and MEP consultants.

- Sefaira is a new player and started with energy and daylight plug-ins for Sketchup and then launched a Revit plug-in.


office_01.skp - SketchUp
Layer0
10/15
11:20 AM
Sefaira Plugin
sefaira for SketchUp
Real Time Analysis
Office
in
Boston
Total Floor Area
101,341
Energy Use
Intensity
45
Total
4,606
Heat Flows into Building
Heat Flows out of Building
Others
Appliance
Lighting
HVAC Heating
South Solar
Ventilation
Ventilation
HVAC Cooling
Glazing Conduction
Infiltration
Wall Conduction
Roof Conduction
Floor Conduction
www.sefaira.com

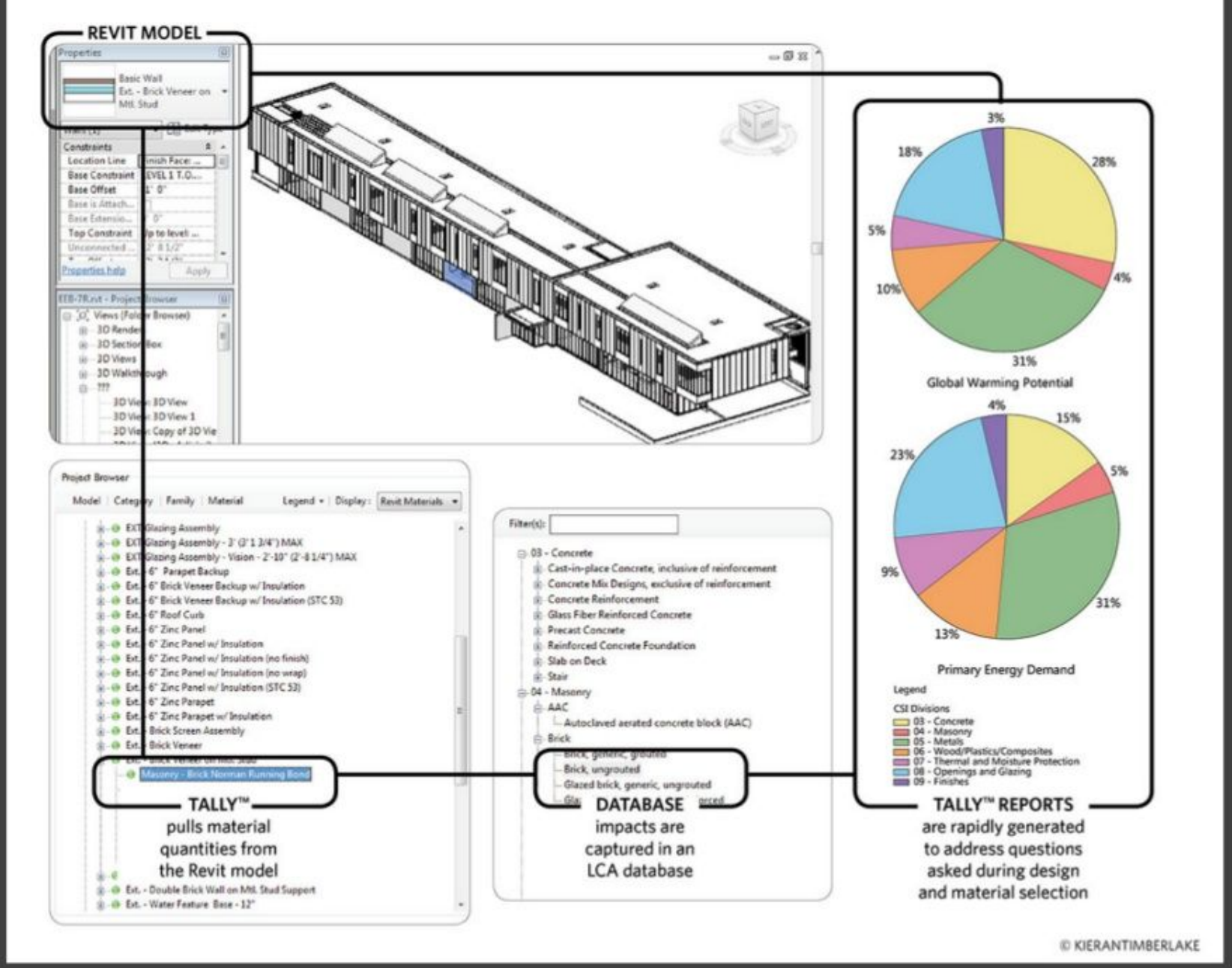


Image: www.kierantimberlake.com

Materials

- Tying BIM to materials can reduce construction waste and streamline the supply chain through more accurate procurement.
- Like carbon footprinting, it also helps us select design solutions that can reduce the overall environmental impact of a building throughout its operation. While BIM has the potential to reduce waste on all construction projects, it is highly beneficial to large complex projects, which tend to generate waste if they are not carefully managed.

Tally

BREEAM Mat 1 Takeoff		
Material Name	Volume (m3)	Green Guide Rating
Brick - Bushbury	54.70	A+
Concrete - Cast In Situ	348.94	B
Finishes - Interior - Fermacell	4.68	A+
Insulation / Support Frame	12.00	A
Insulation / Thermal Barriers - Batt insulation	61.10	A
Insulation / Thermal Barriers - Cavity Fill	506.20	A
Insulation / Thermal Barriers - External Wall Insulation	210.16	B
Insulation / Thermal Barriers - Rigid insulation	290.78	B
Plasterboard	39.51	A+
Plastic - GRP - Glass Reinforced Plastic	1.91	B
Roofing - Metal	1.86	A

MATERIALS USE

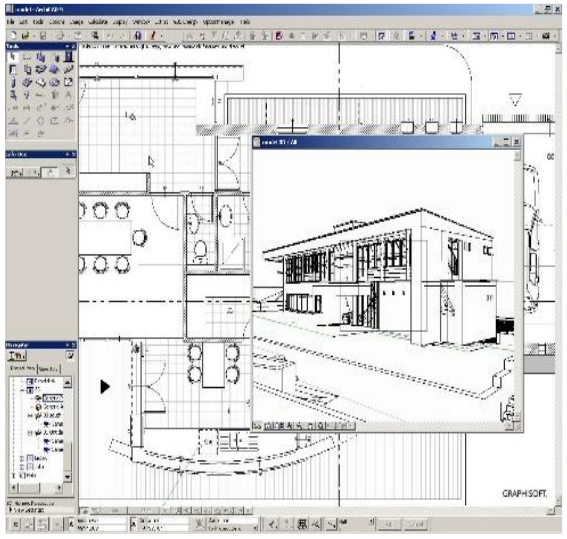
Bley Sleeping House Addition by Agruppo. BIM model and photos by Andrew Nance.

28

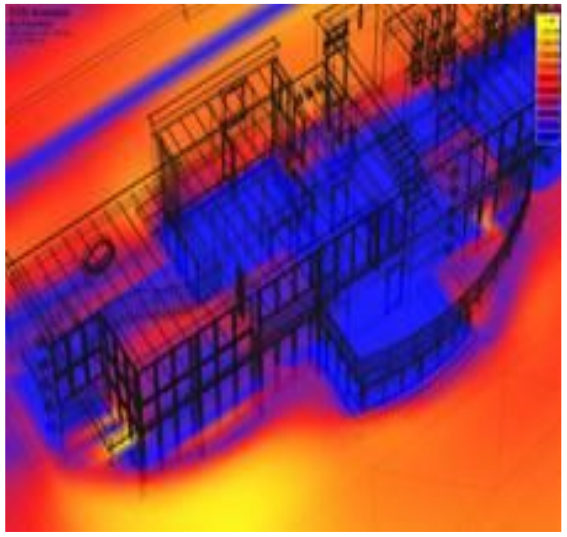
Ecodesigner “Energy Analysis with ArchiCAD”

ecodesigner

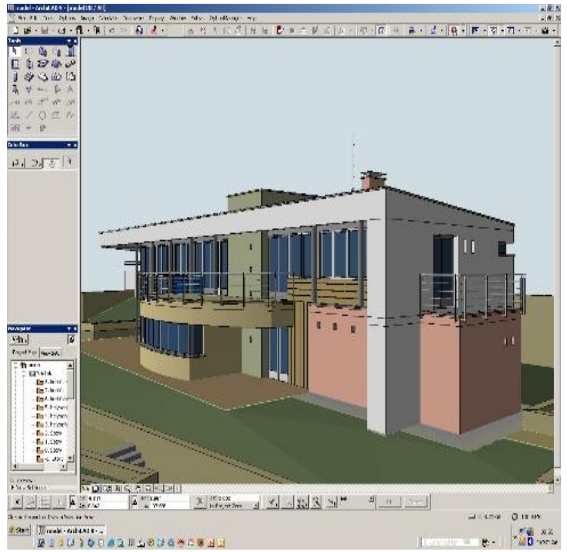
- Ease-of-use and smooth workflow
- Integrated solutions
- Evaluate alternatives early and throughout the design process



GRAPHISOFT ARCHICAD



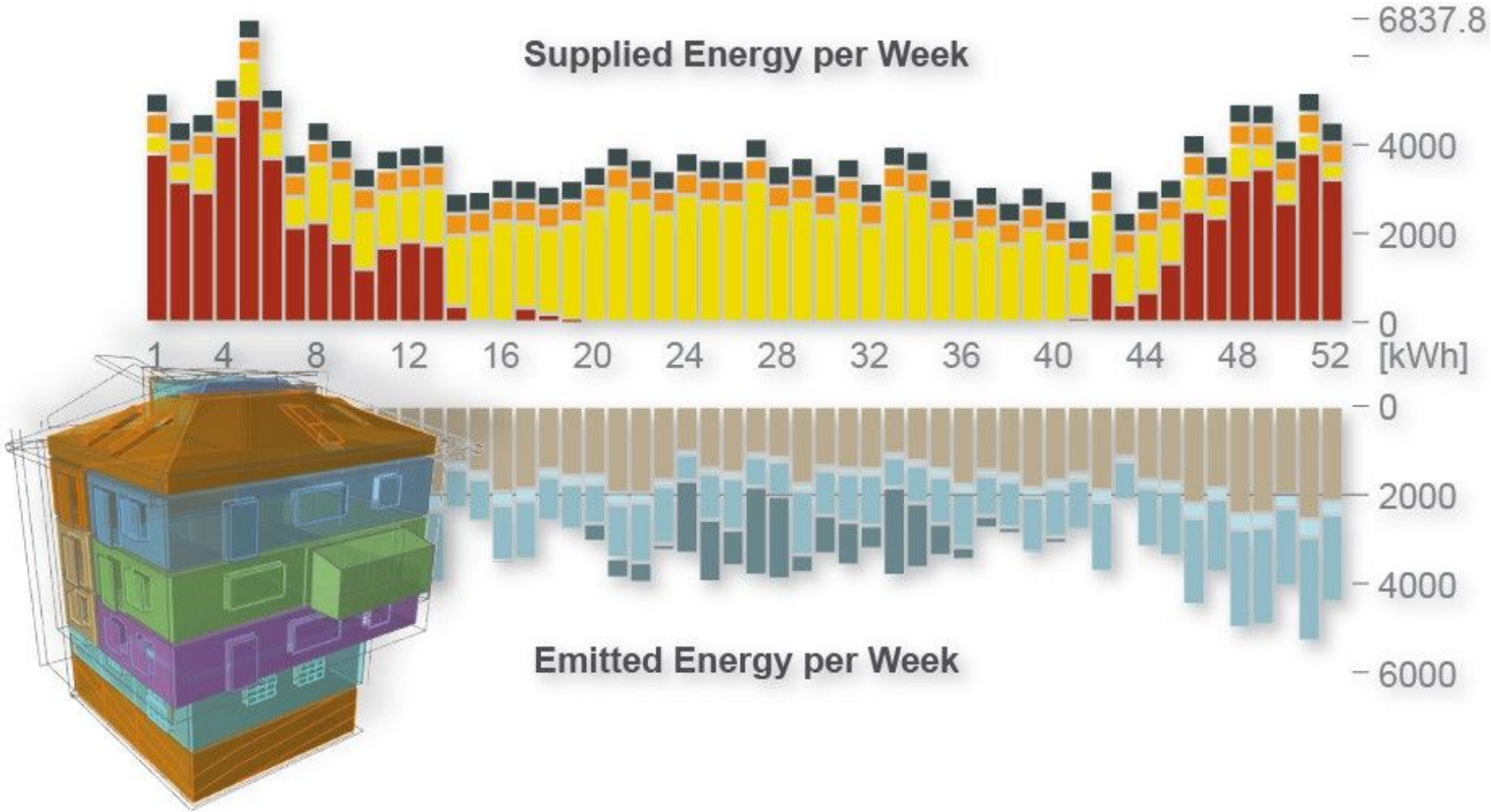
Energy simulation solutions



GRAPHISOFT ARCHICAD

Detailed Energy Performance Evaluation Report

EcoDesigner STAR displays fully customizable, detailed reports about various, energy-related characteristics of the individual thermal blocks,

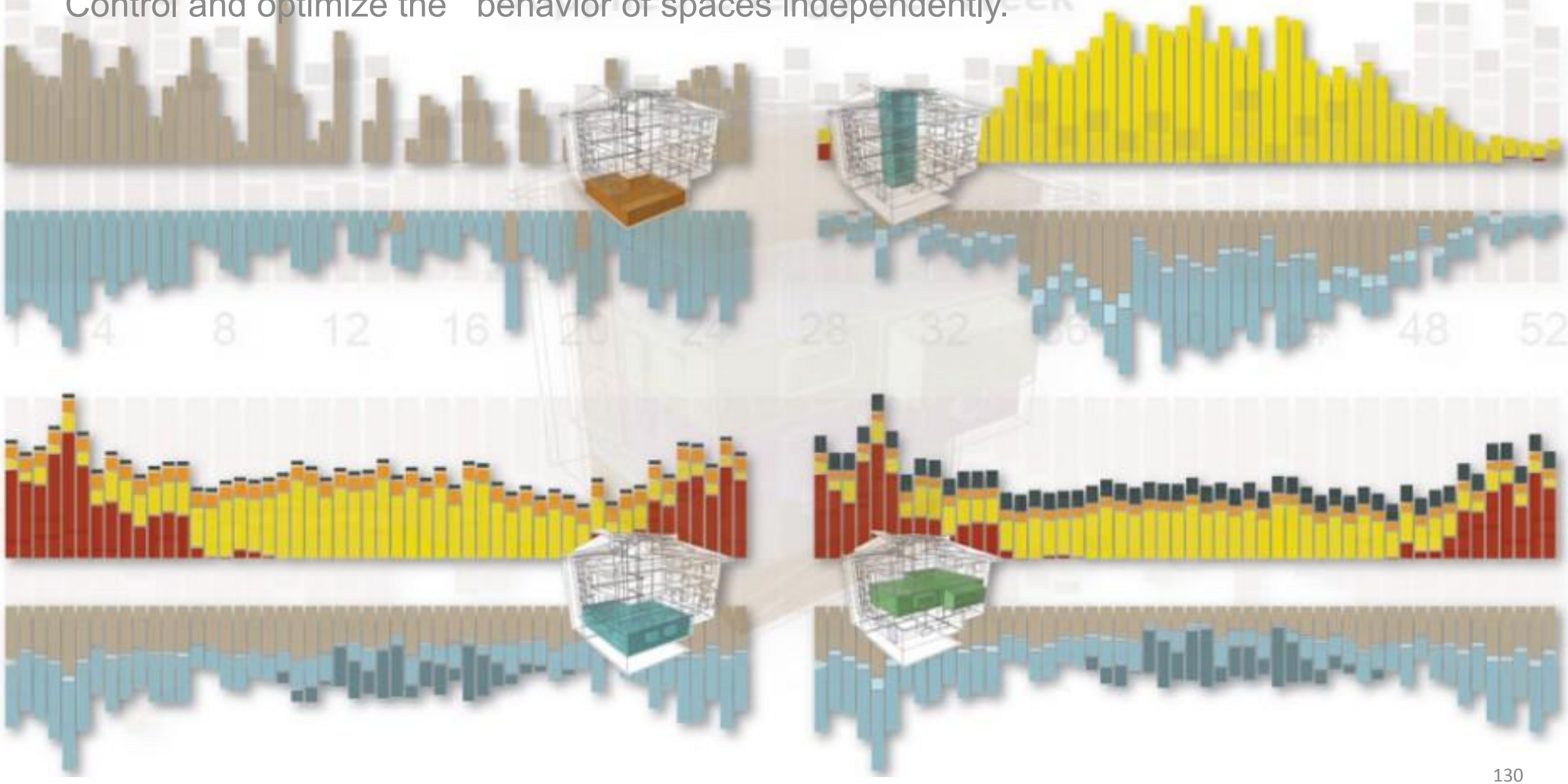


Building Information Model

Building Energy Model

Detailed Energy Performance Monitor the entire project's energy performance.

Control and optimize the behavior of spaces independently.



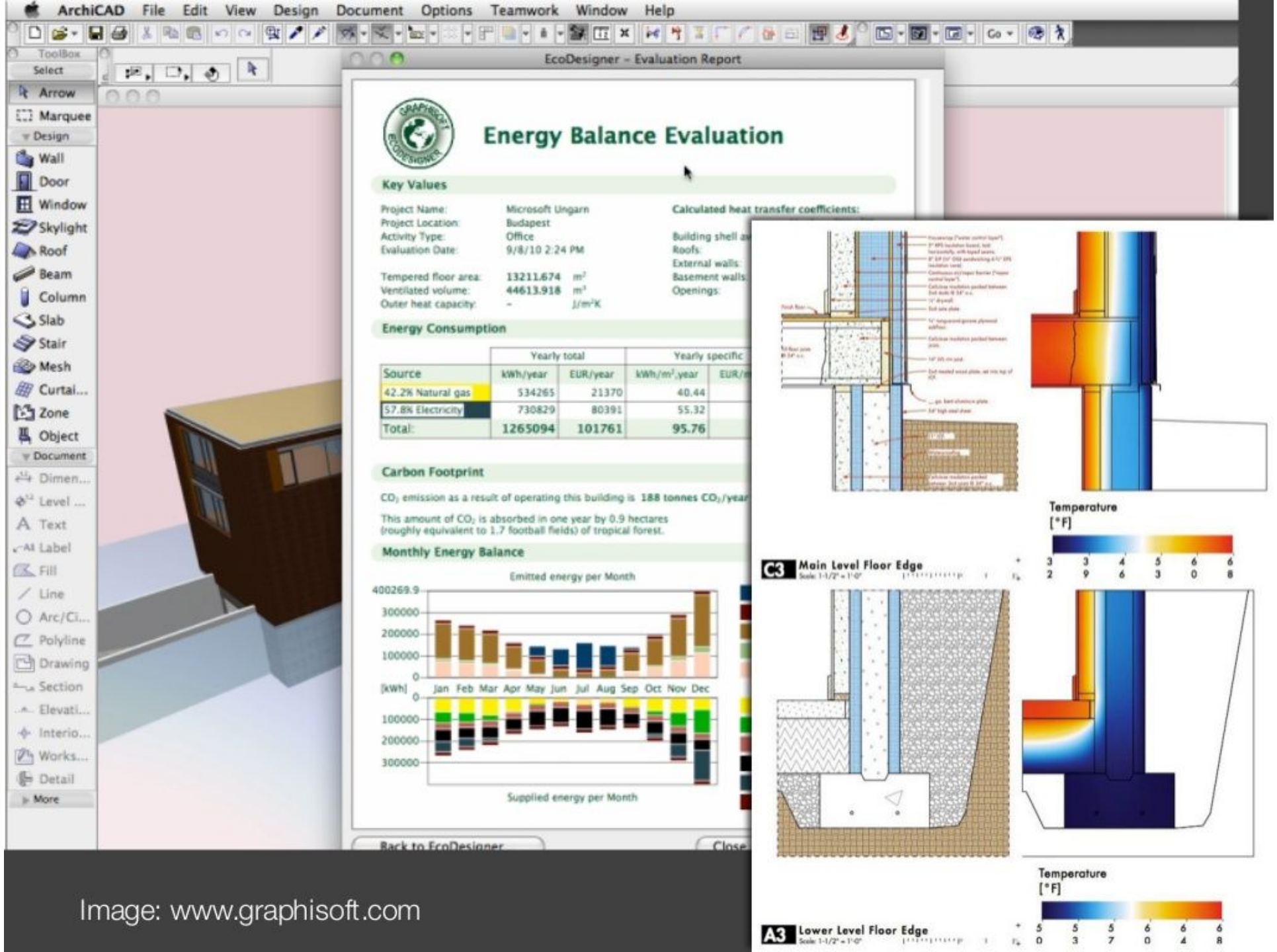
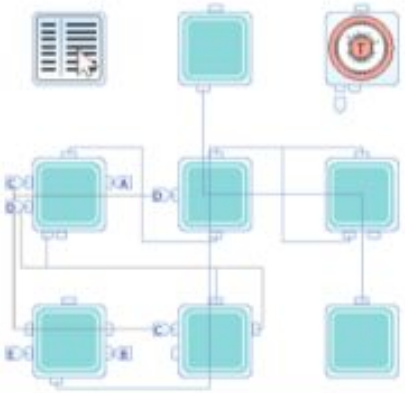


Image: www.graphisoft.com

bentley

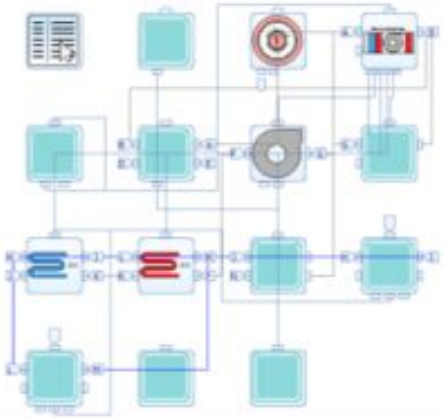
Energy analysis - AECOsim Energy Simulator

Water source heat pump



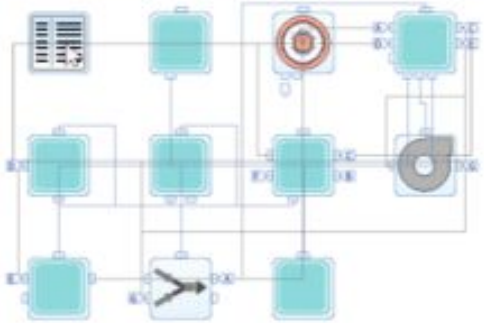
49 KWh/m²

Central VAV



78 KWh/m²

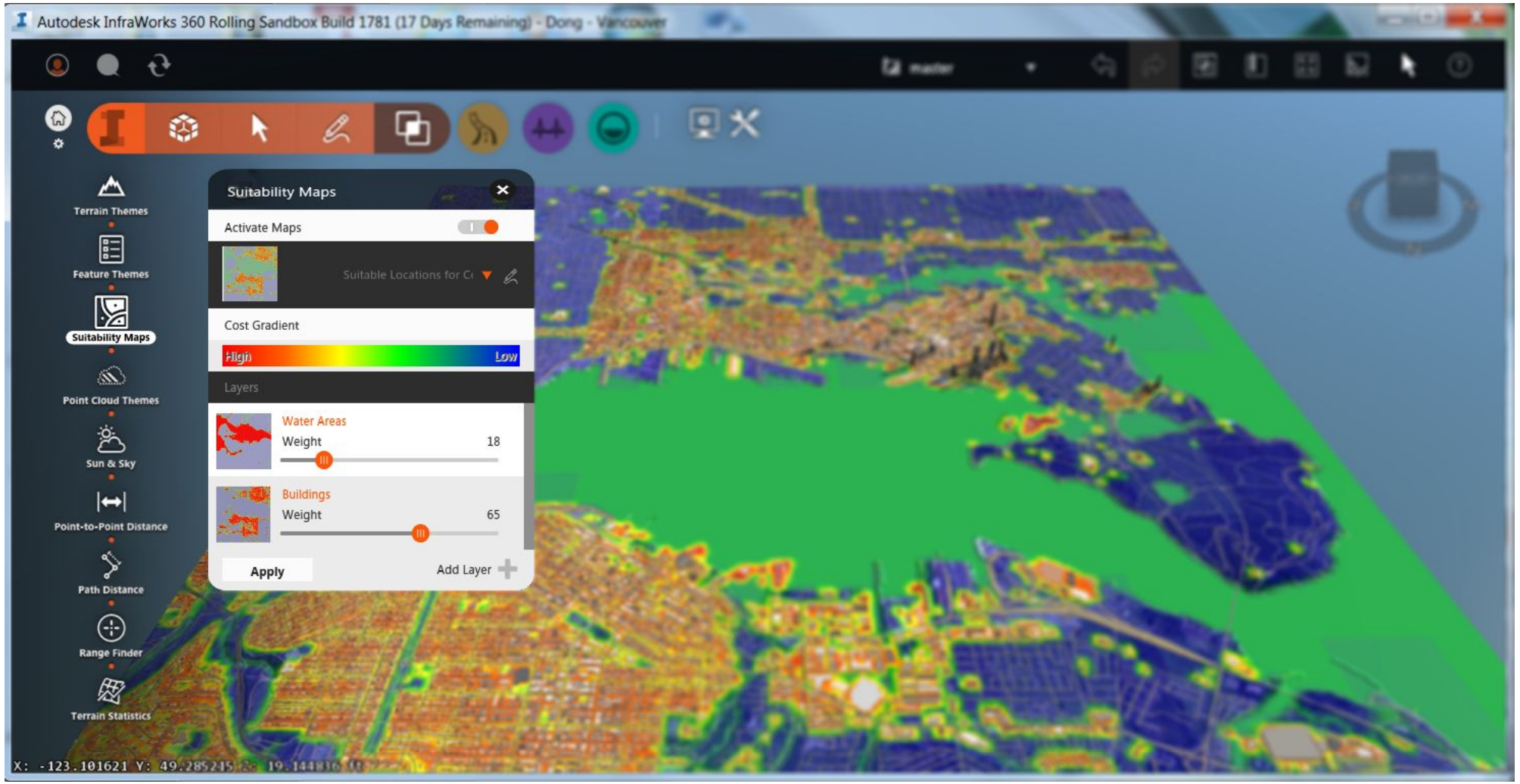
Packaged VAV



66 KWh/m²

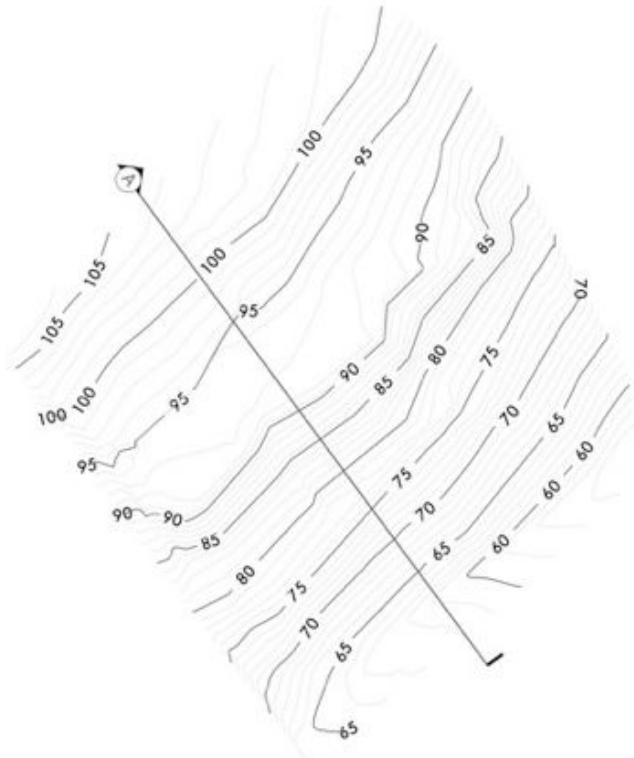
- Heat Rejection
- Pumps
- Fans
- Interior Lighting
- Cooling
- Heating

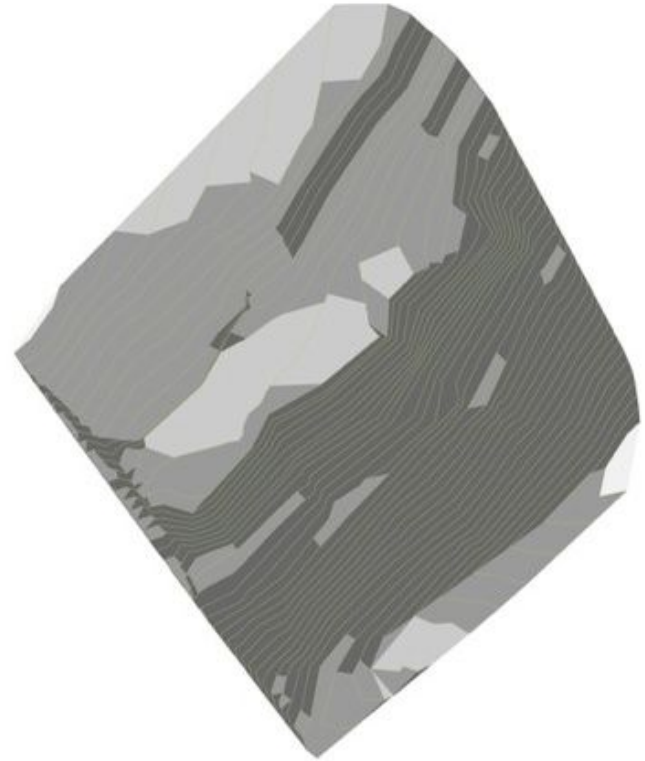
Suitability Maps for InfraWorks 360

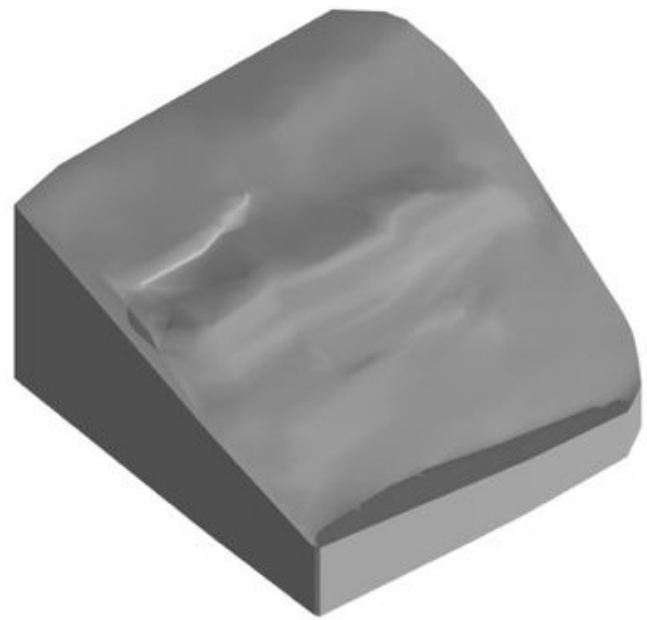


Suitability Maps for InfraWorks 360

SITE ANALYSIS



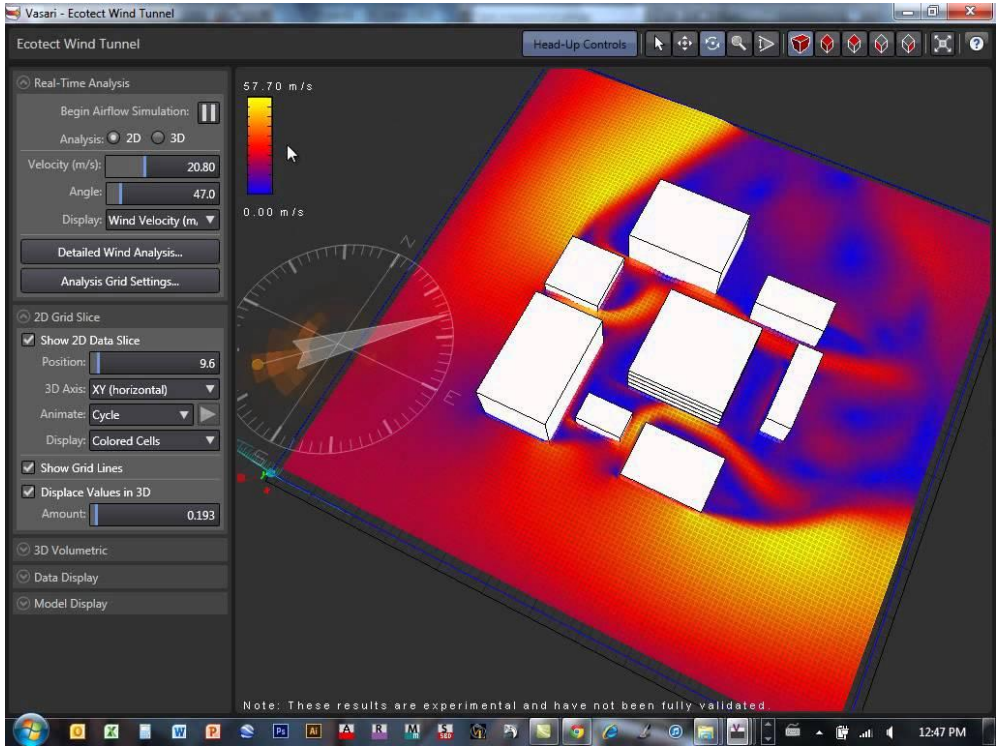




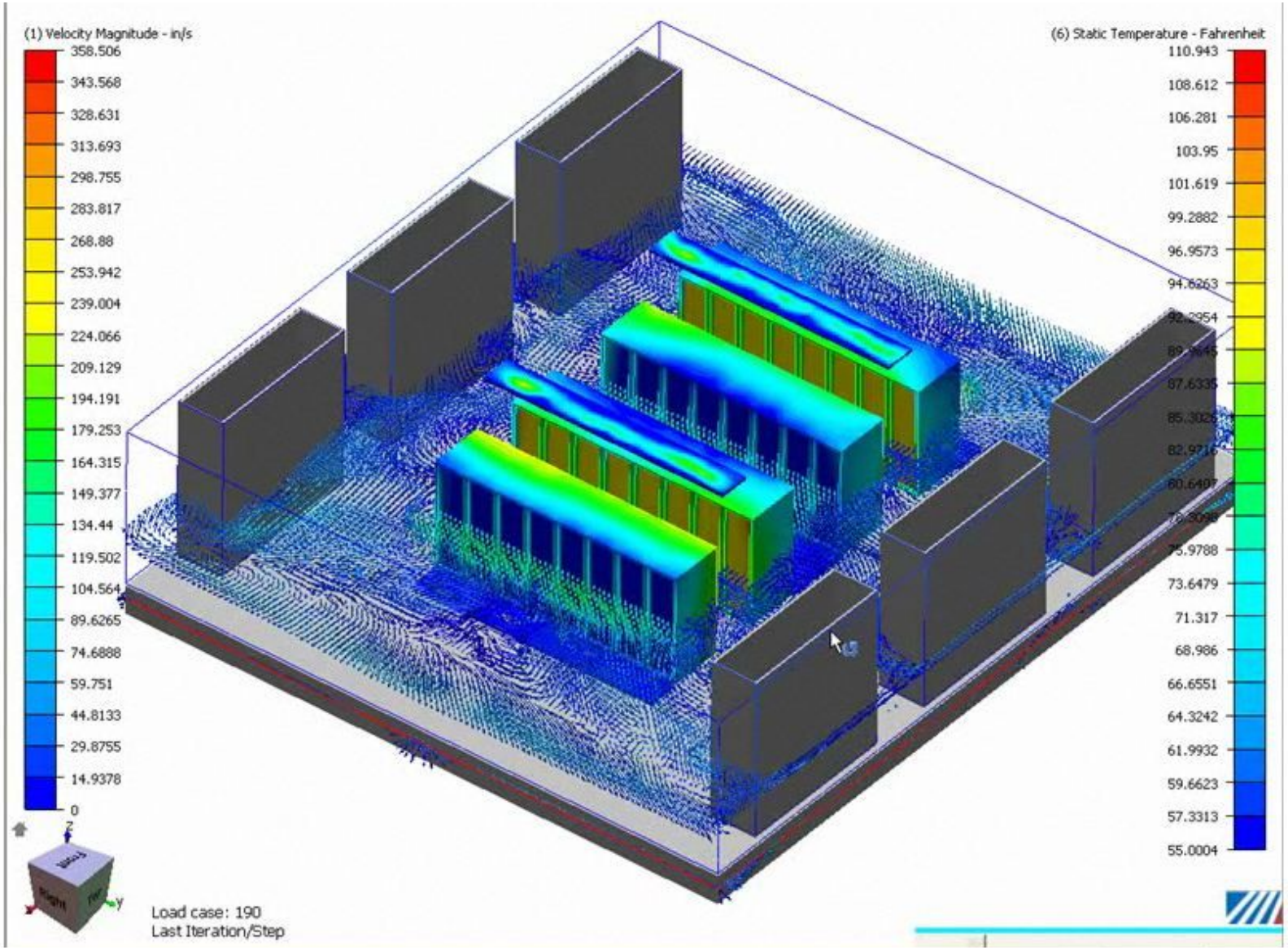
Applications: Autodesk Vasari

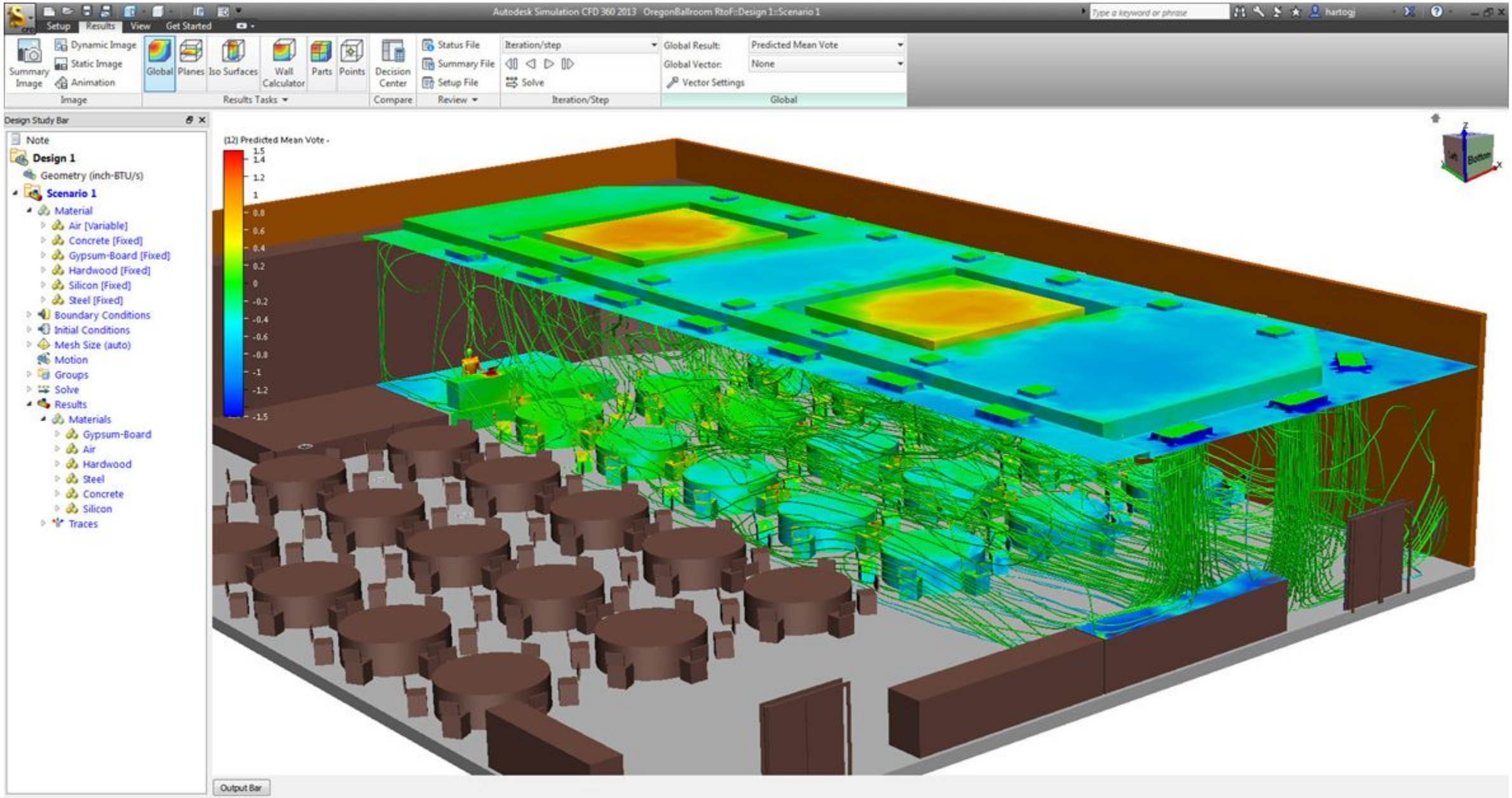
- conceptual building design (parametric massing) and provides energy/carbon analysis,solar radiation analysis, and more, you can create, analyze, and refine whole building models.

- Conceptual building models created with Vasari can also be used in Autodesk Revit to develop more detailed building models.

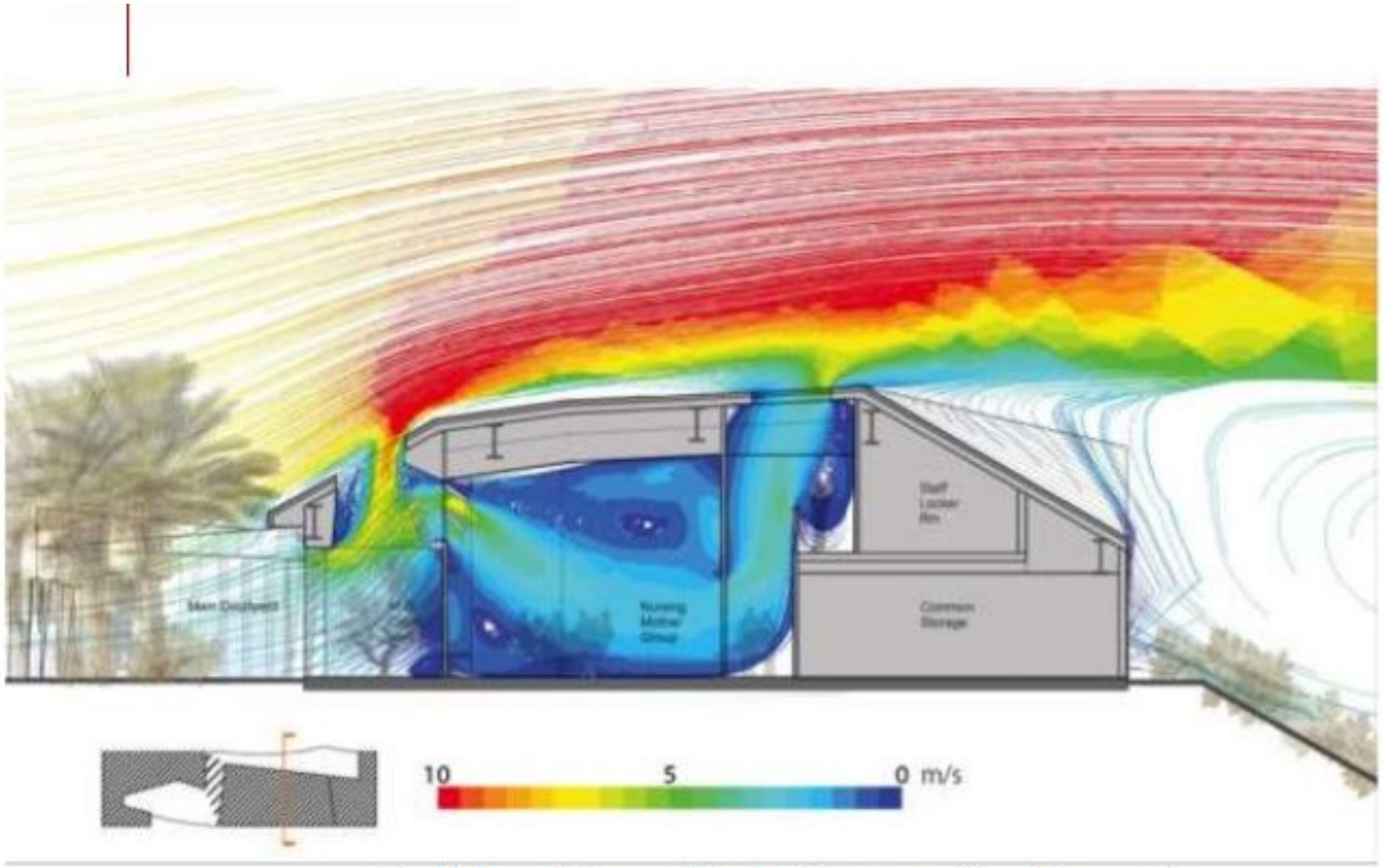


Autodesk CFD

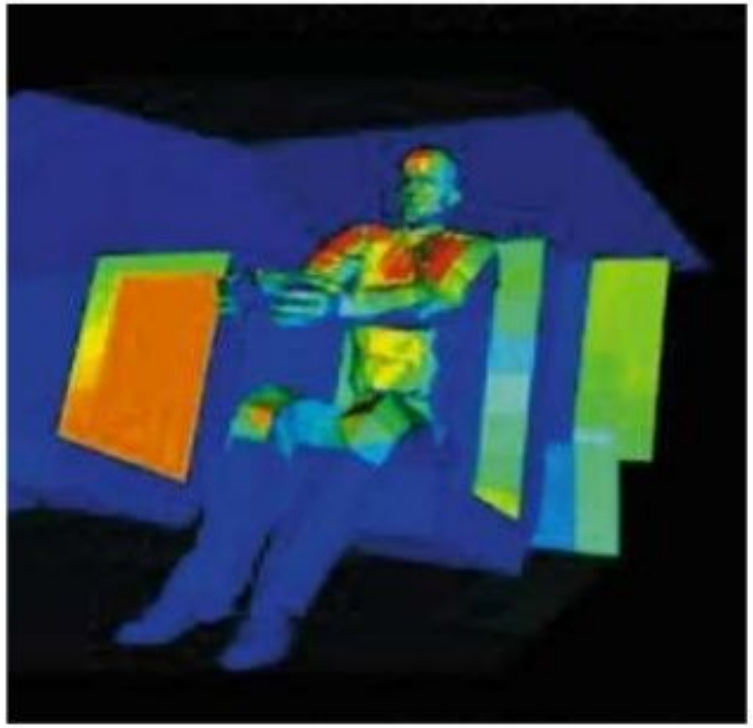



Autodesk Simulation CFD 360 2013 OregonBallroom Rtof::Design 1::Scenario 1
Setup
Results
View
Get Started
Summary Image
Dynamic Image
Static Image
Animation
Global
Planes
Iso Surfaces
Wall Calculator
Parts
Points
Decision Center
Status File
Summary File
Setup File
Iteration/step
Solve
Global Result:
Predicted Mean Vote
Global Vector:
None
Vector Settings
Image
Results Tasks
Compare
Review
Iteration/Step
Global
Design Study Bar
Note
Design 1
Geometry (inch-BTU/s)
Scenario 1
Material
Air [Variable]
Concrete [Fixed]
Gypsum-Board [Fixed]
Hardwood [Fixed]
Silicon [Fixed]
Steel [Fixed]
Boundary Conditions
Initial Conditions
Mesh Size (auto)
Motion
Groups
Solve
Results
Materials
Gypsum-Board
Air
Hardwood
Steel
Concrete
Silicon
Traces
(12) Predicted Mean Vote -
1.5
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.5
Output Bar

Computational Fluid Dynamics (CFD)

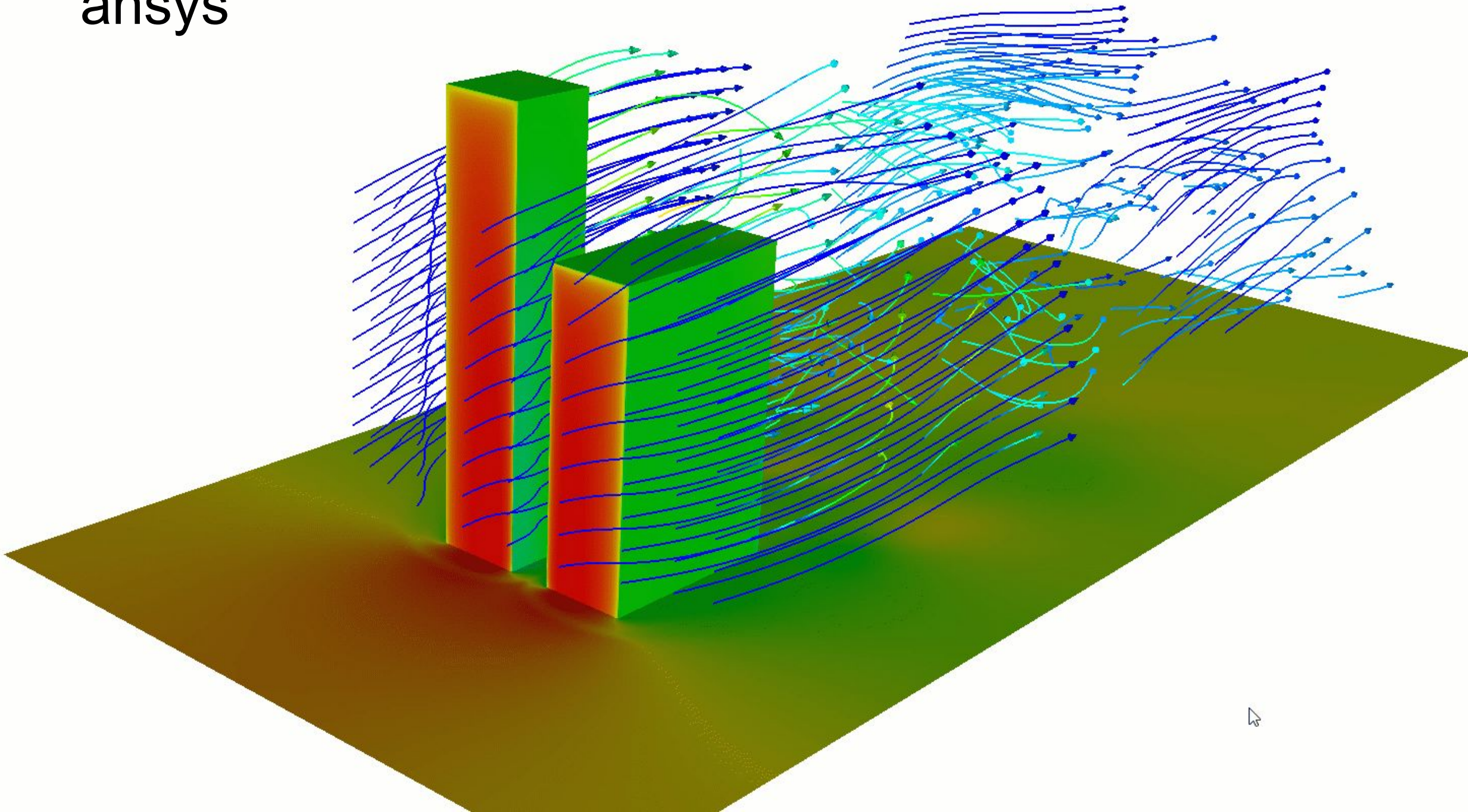


Building Form Optimization for Natural Ventilation with Using CFD simulation, ISOENV with MODU Architecture NY, 2014

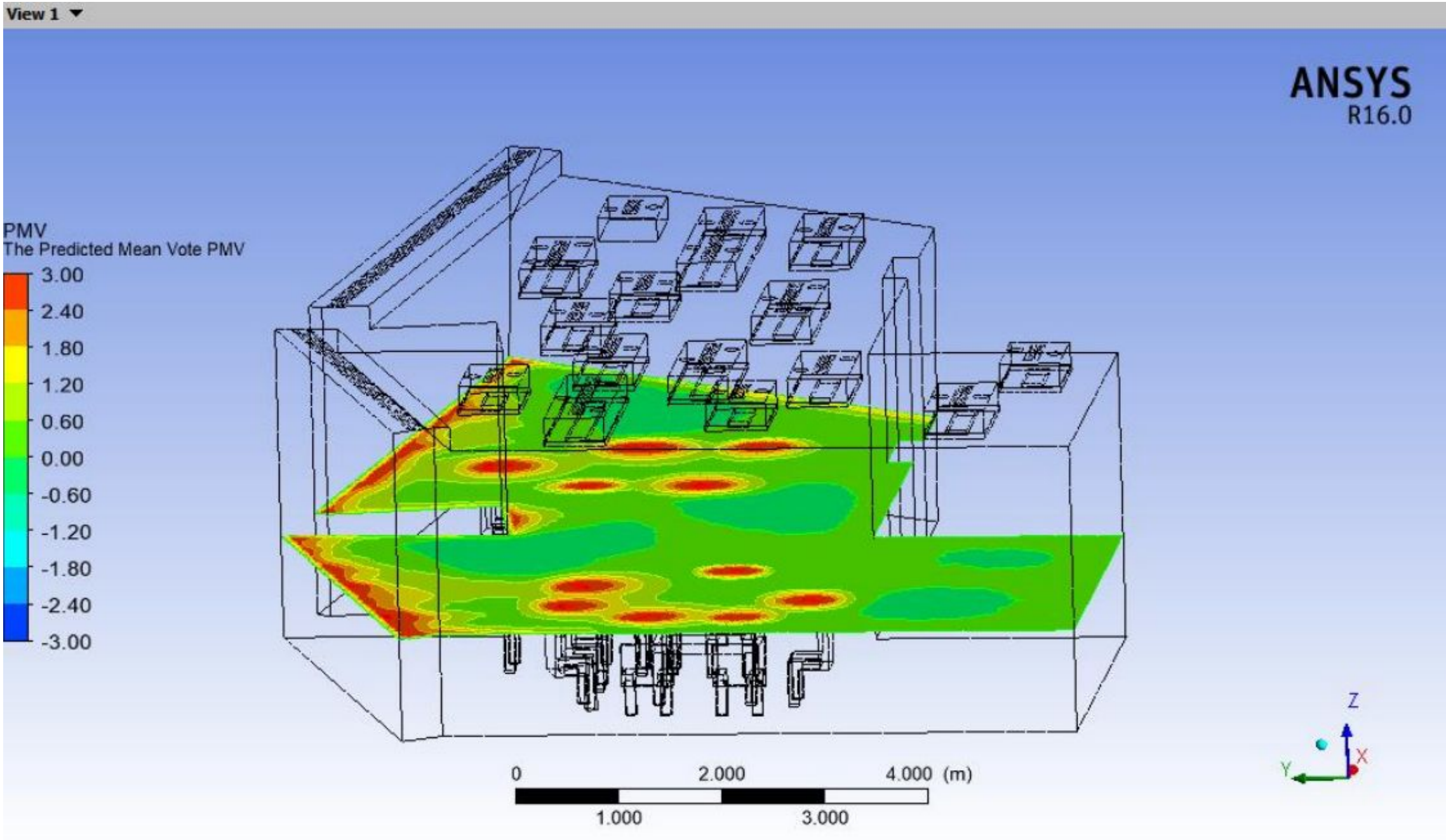


Automation simulation

ansys



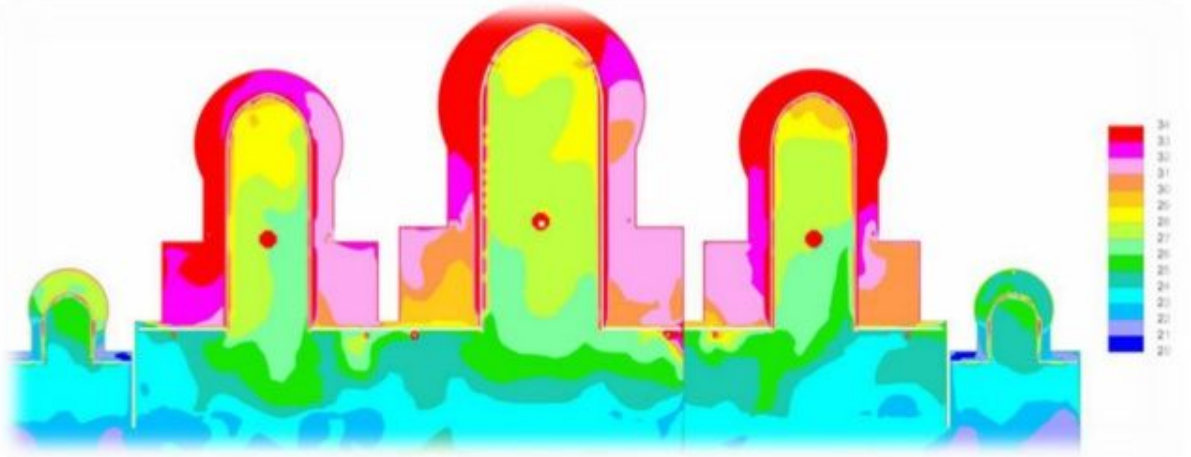
National Museum of Qatar (NMoQ)



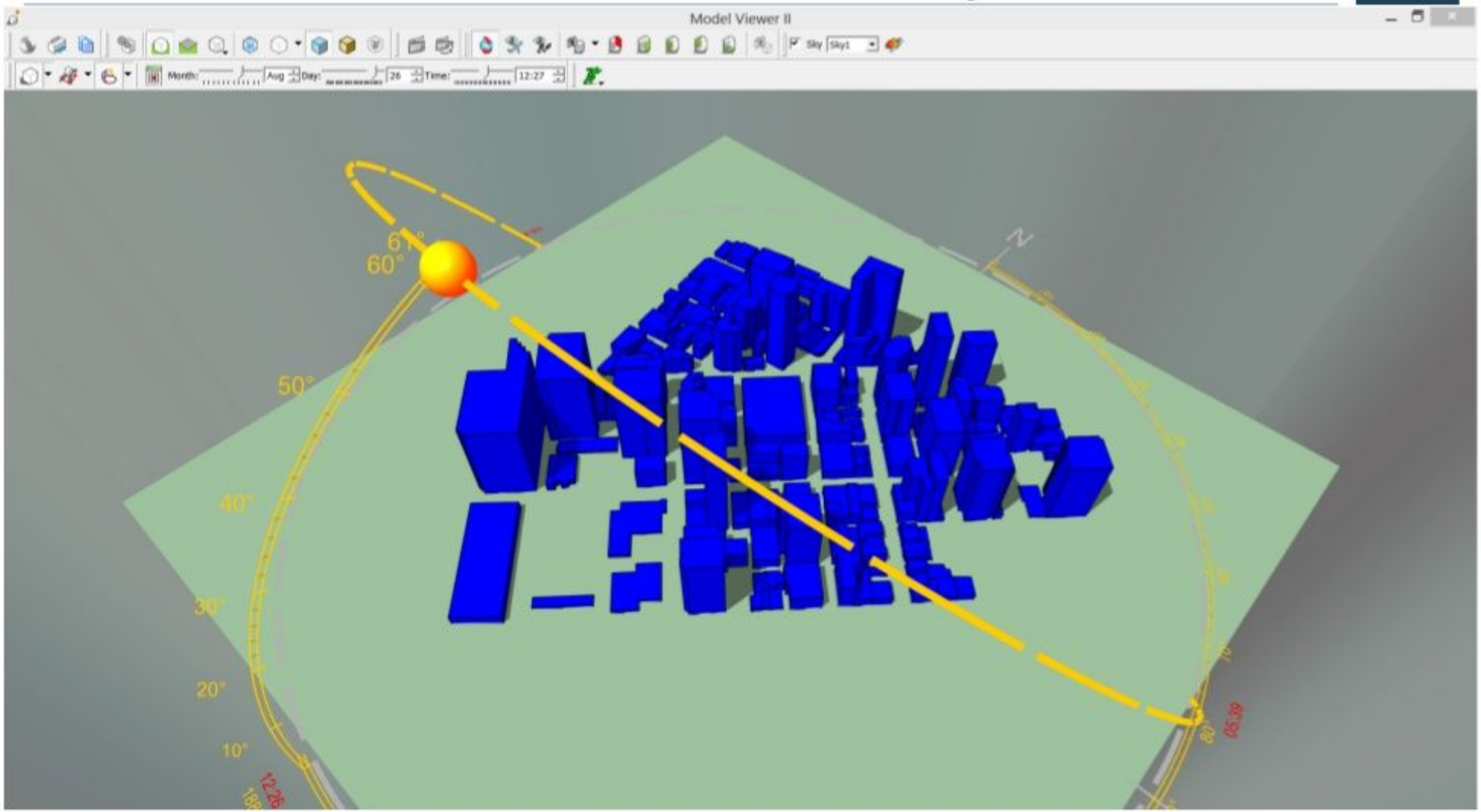
IES

Sheik Zayad Mosque, Abu Dhabi, UAE

IES were appointed to conduct thermal simulation analysis of the mosque using their building analysis software to determine internal thermal comfort conditions, optimise HVAC system performance and verify building safety.

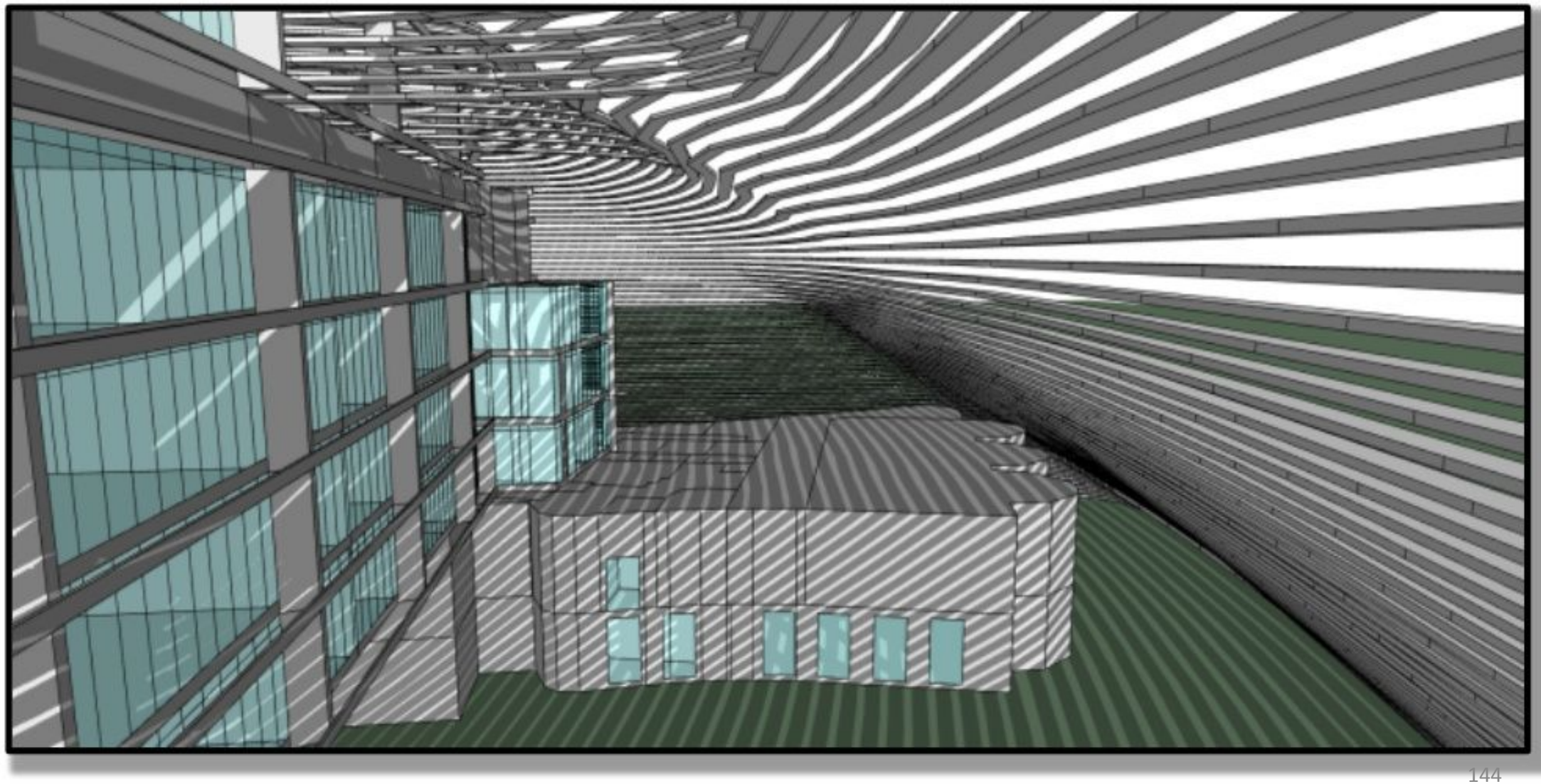


Solar Shadow Study

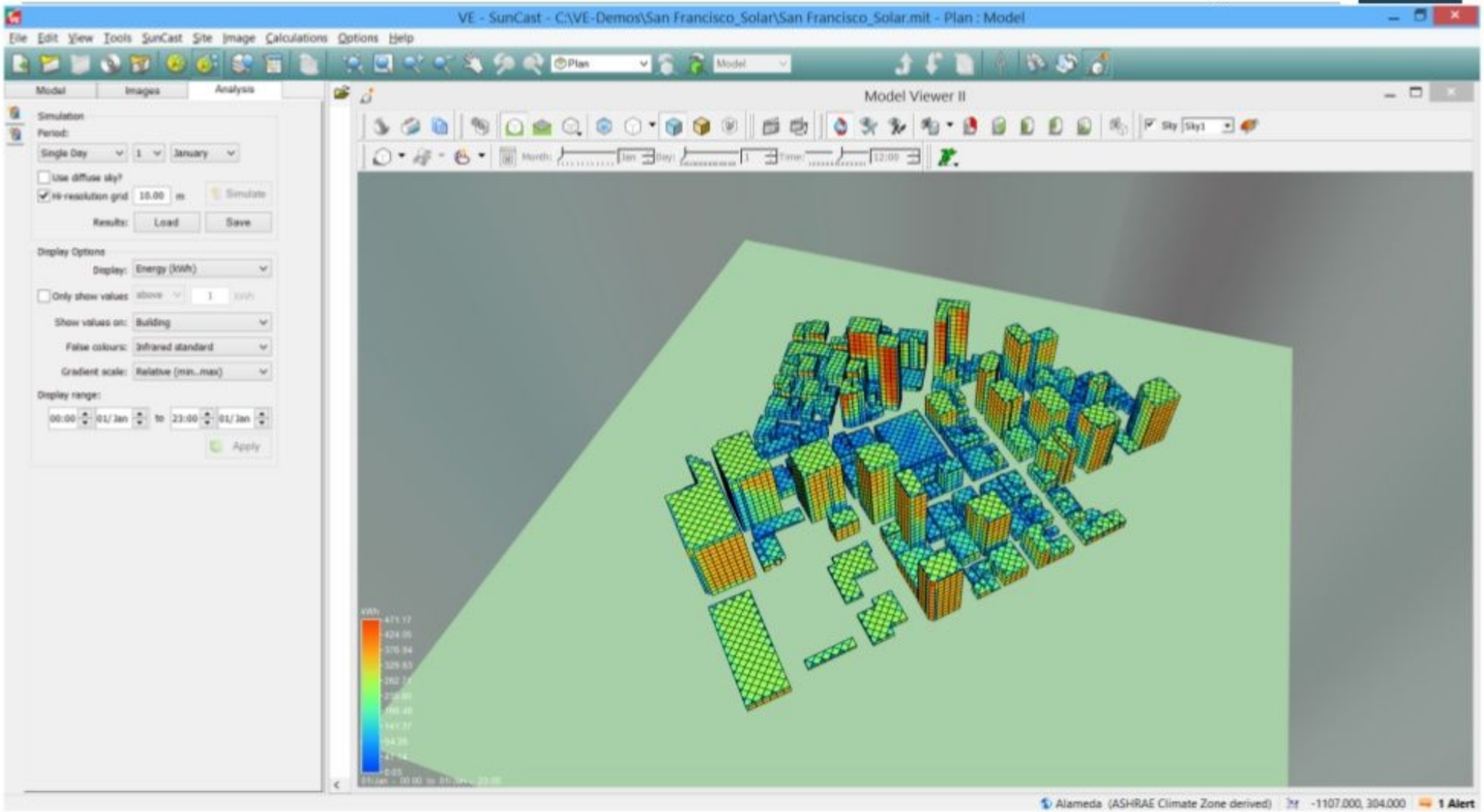


Shadow studies

Tracking Internal Solar Radiation

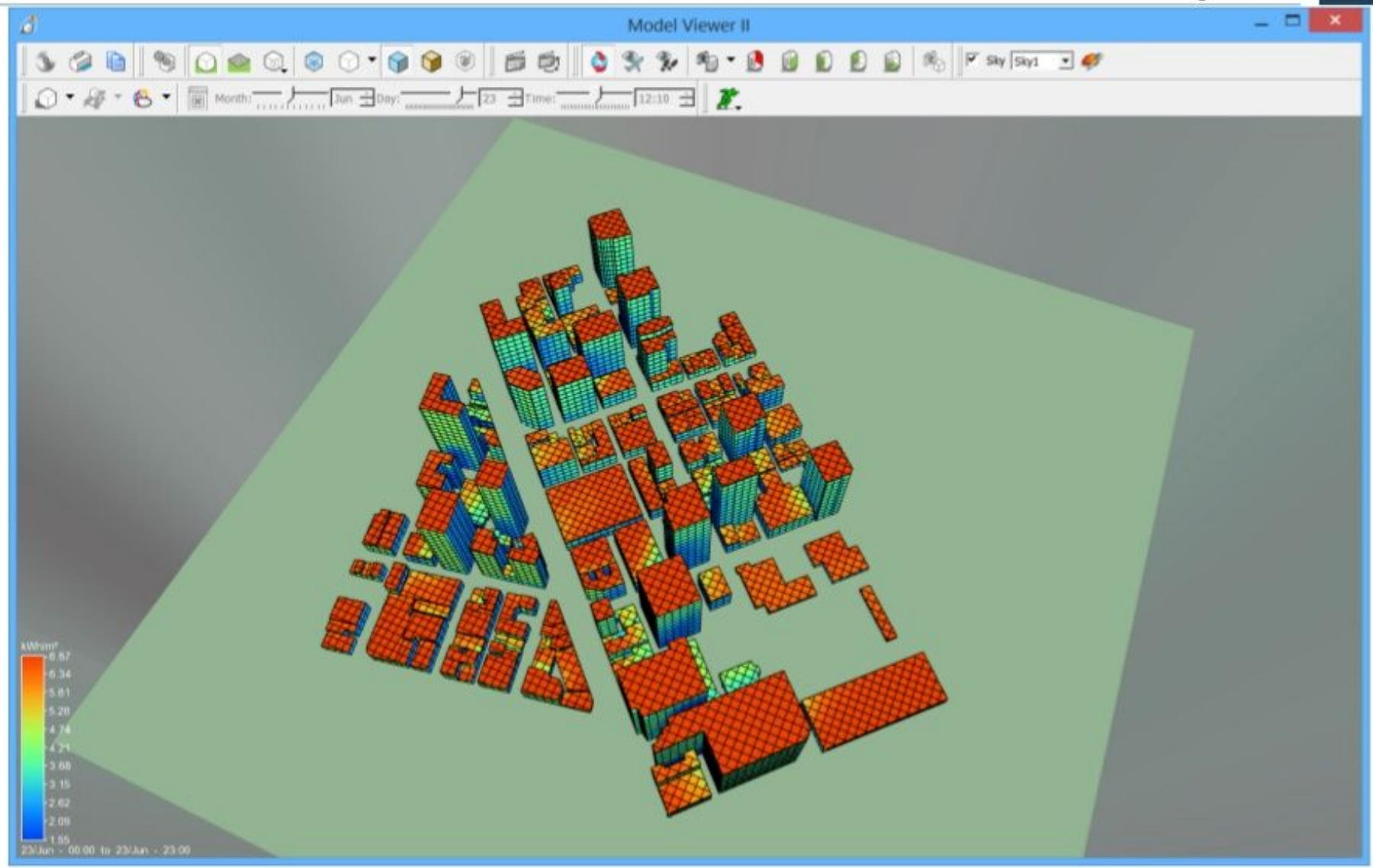


Surface Solar Radiation: Winter Day



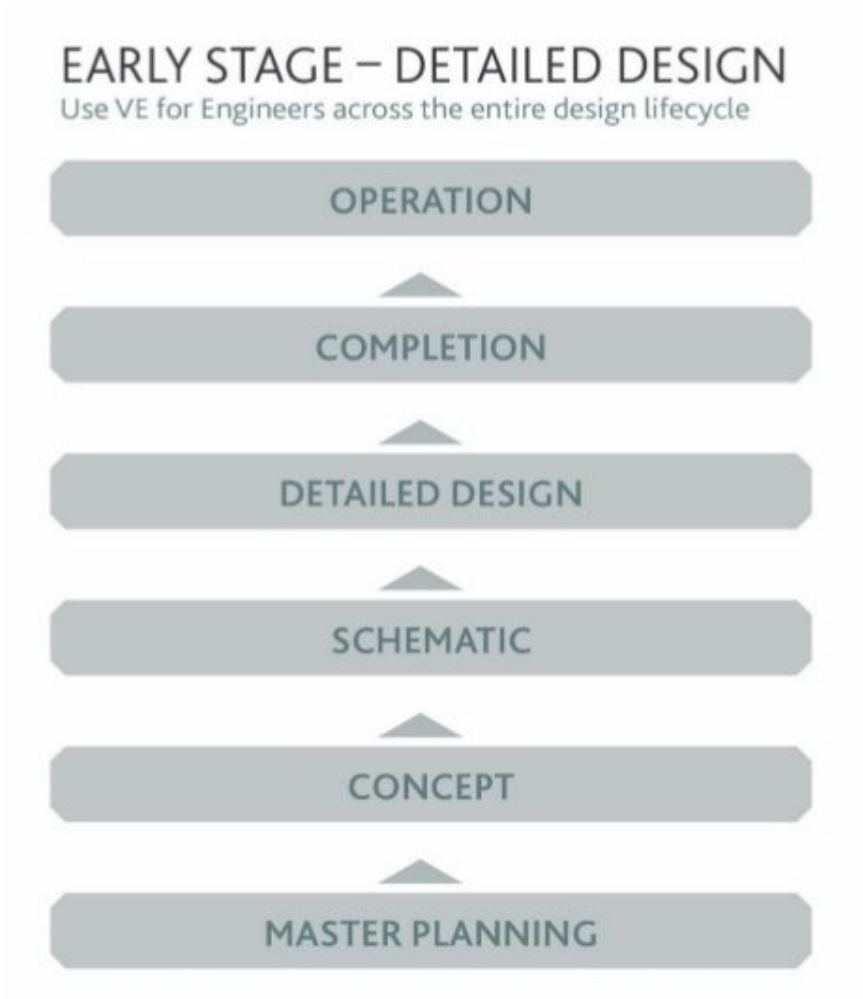
Surface Solar Radiation: 15 January (Red High, Blue Low)

Surface Solar Radiation: Summer Day



Surface Solar Radiation: 23 June (Red High, Blue Low)

Who is the typical building simulation client?



ARCHITECTURAL

- Designers
- Architects
- Master planners
- Urban designers
- Interior Designers

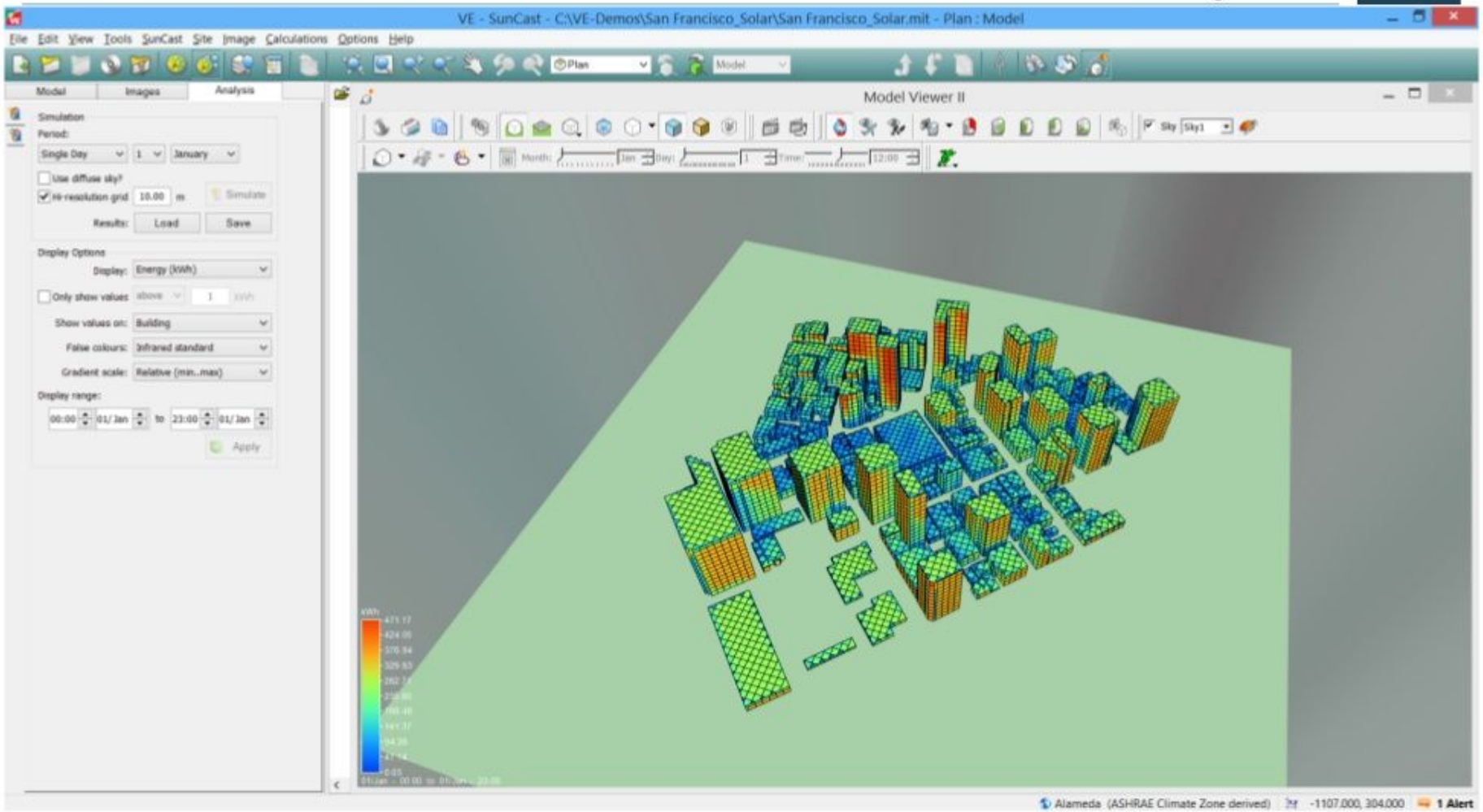
ENGINEERS

- HVAC
- Mechanical
- Electrical
- Building Physics
- Other “green” rating systems

GREEN CONSULTANTS

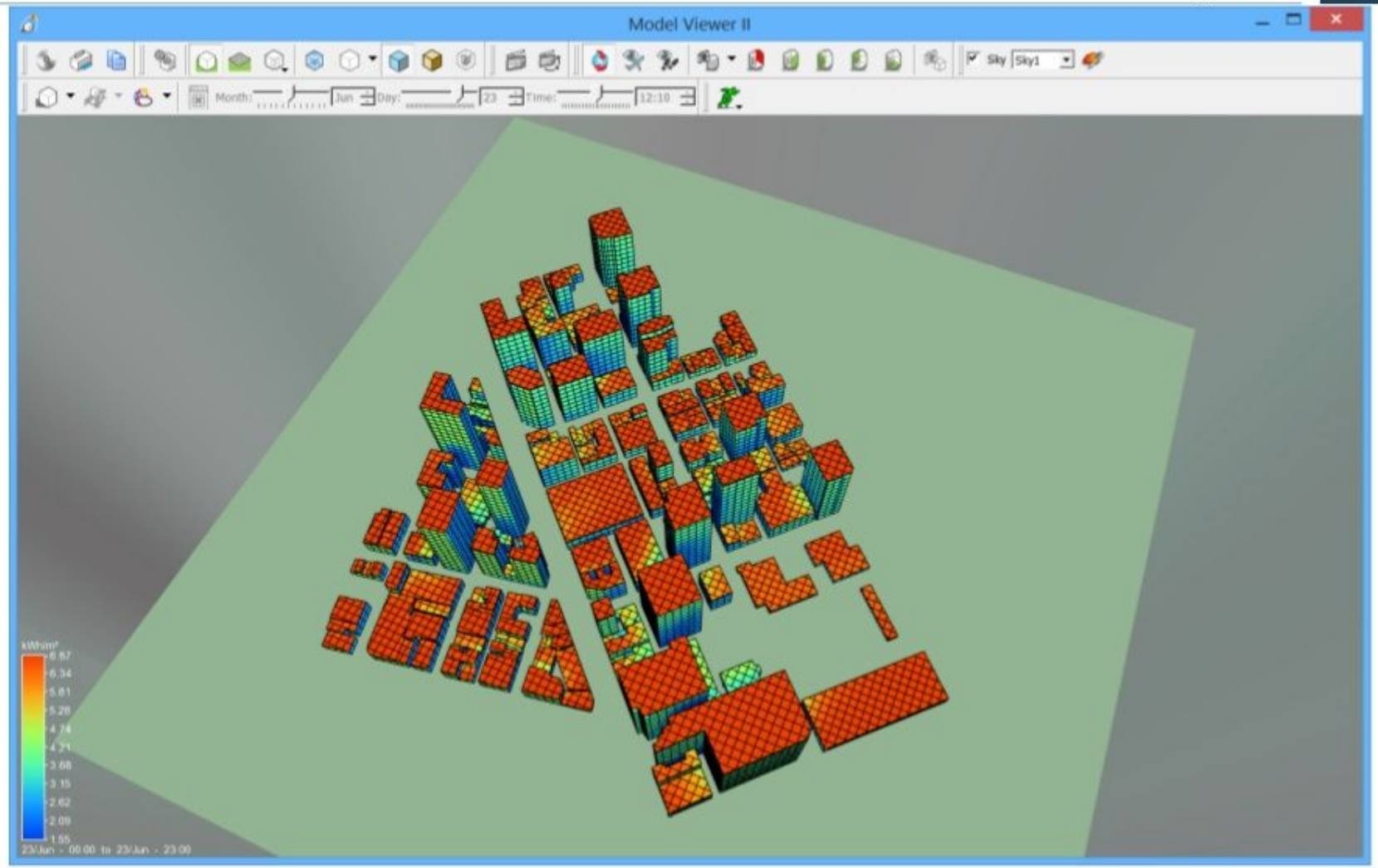
- BREEAM
- LEED
- DGNB
- Estidama
- Other “green” rating systems

Surface Solar Radiation: Winter Day



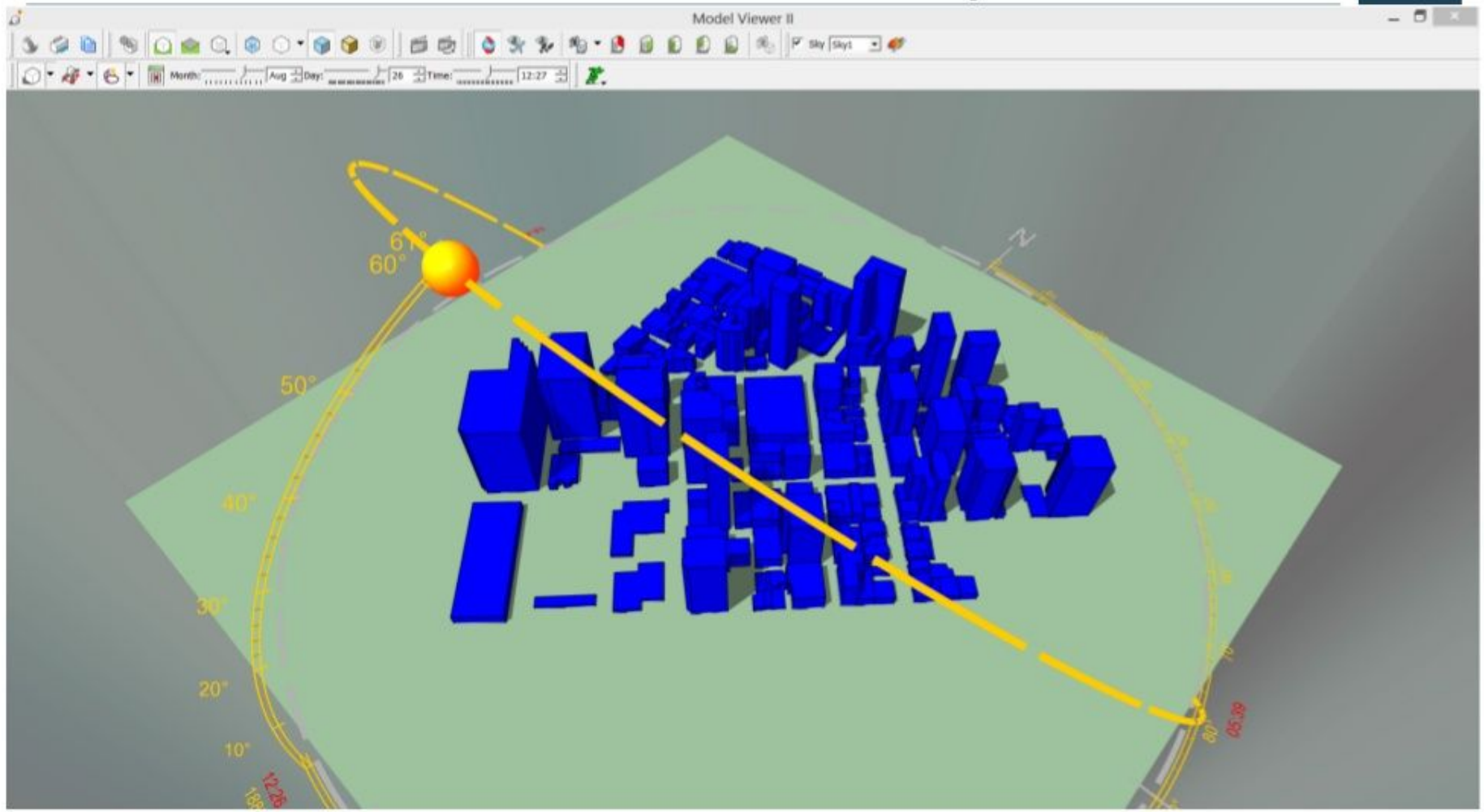
Surface Solar Radiation: 15 January (Red High, Blue Low)

Surface Solar Radiation: Summer Day



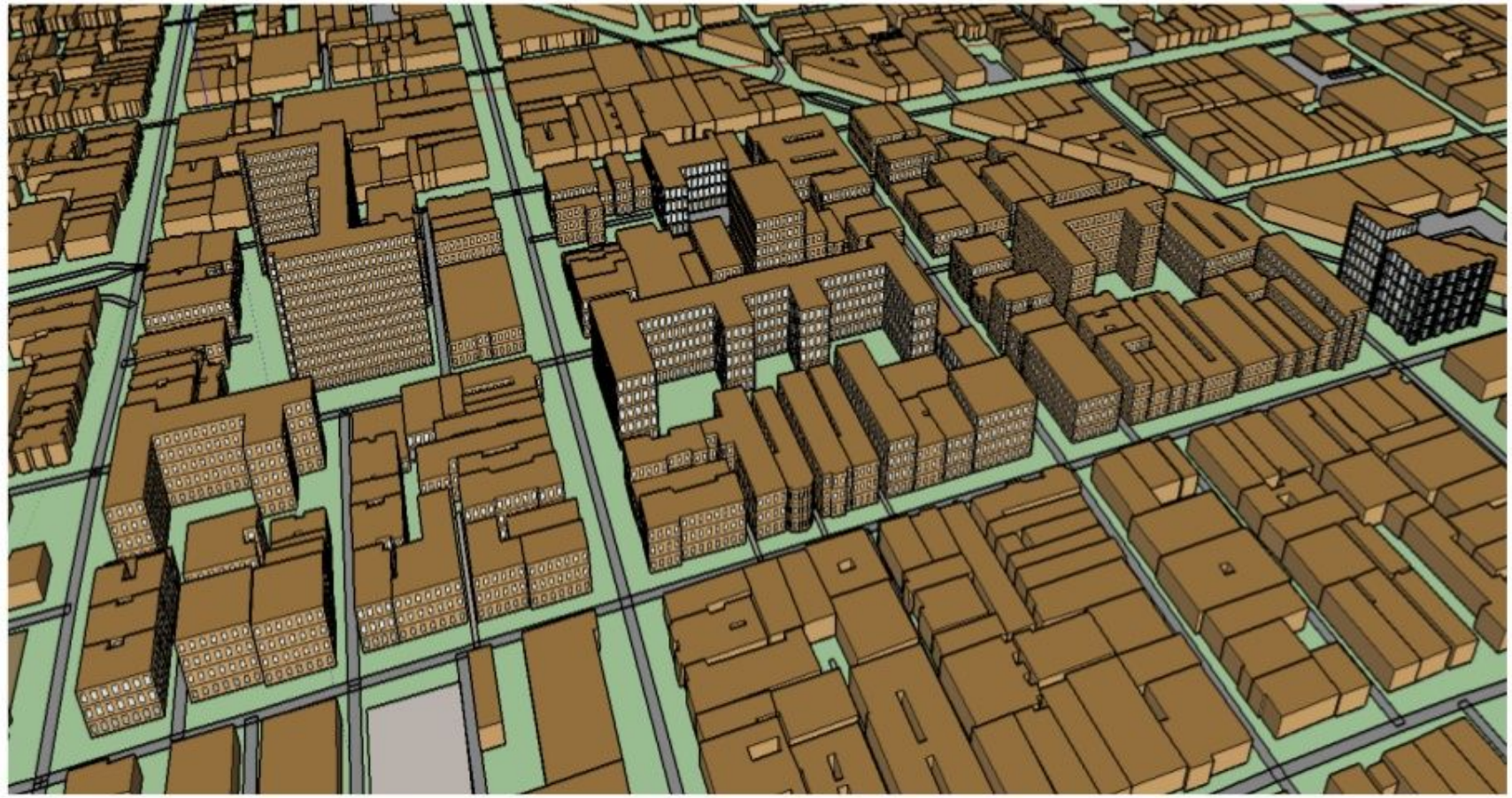
Surface Solar Radiation: 23 June (Red High, Blue Low)

Solar Shadow Study



Shadow studies

Energy Analysis

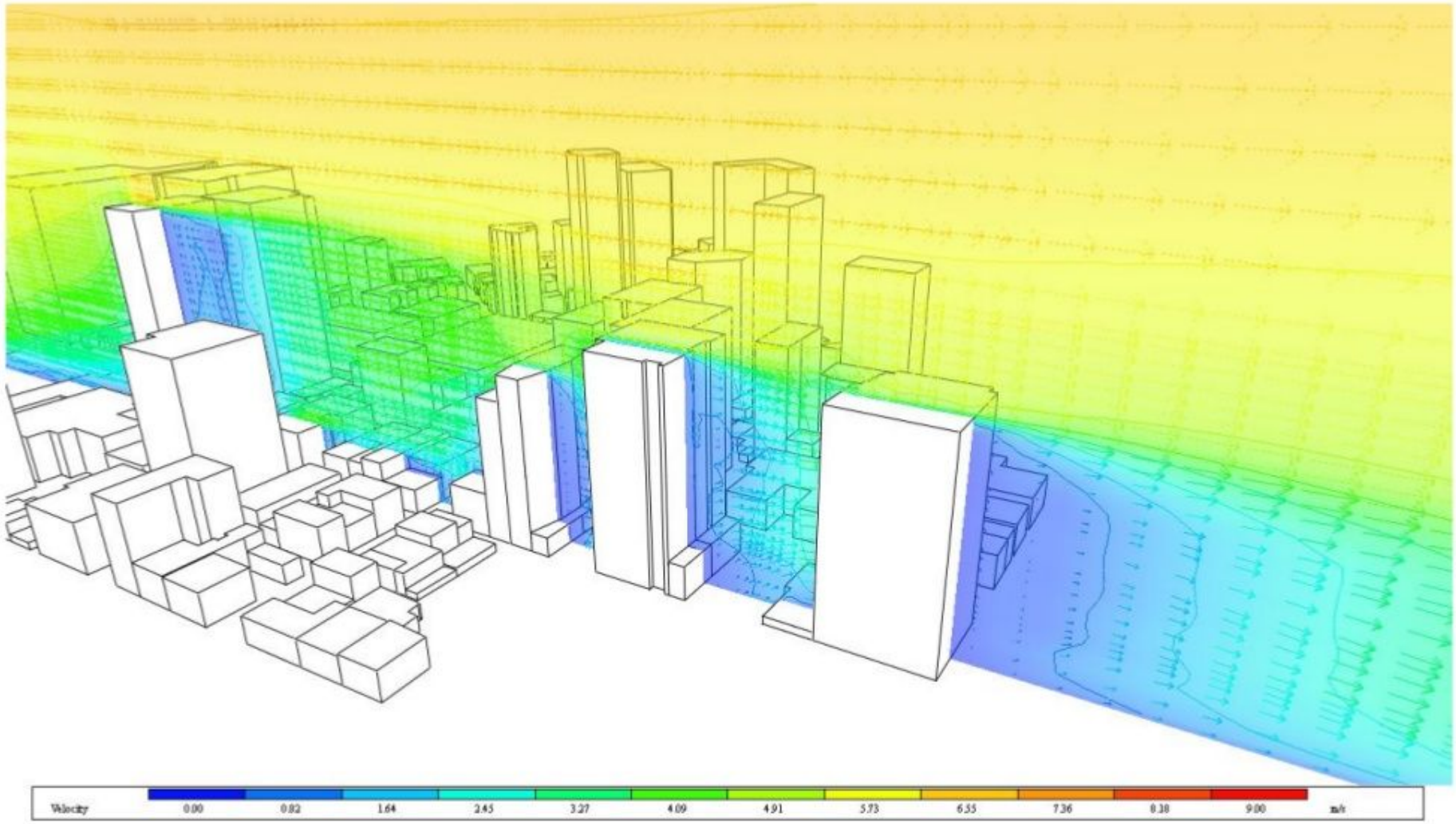


District buildings modelled in more detail

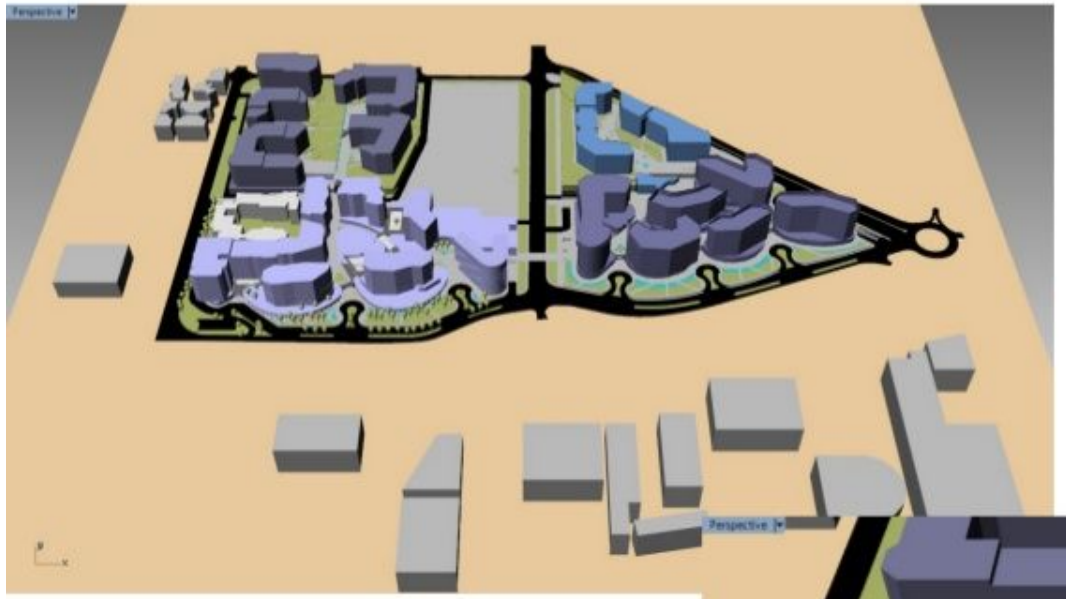
Energy Analysis

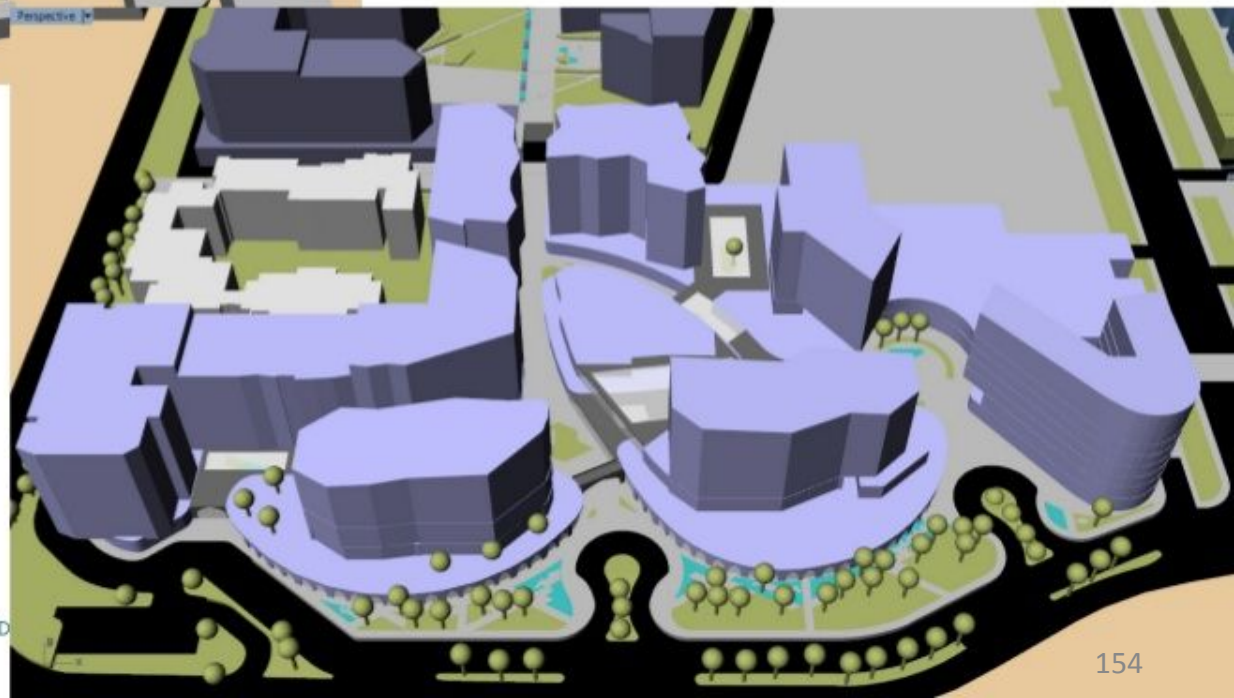
Define buildings by spaces types for general analysis

VE-Pro: External Air Flow

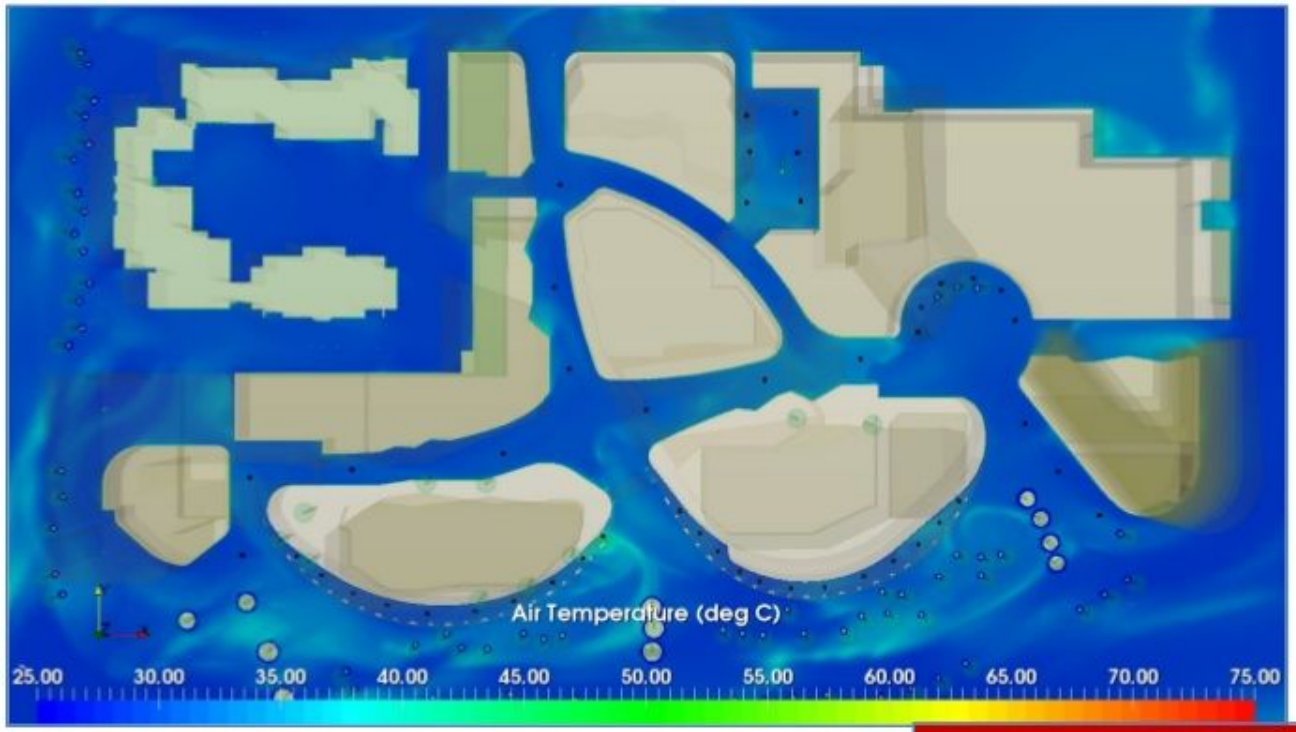


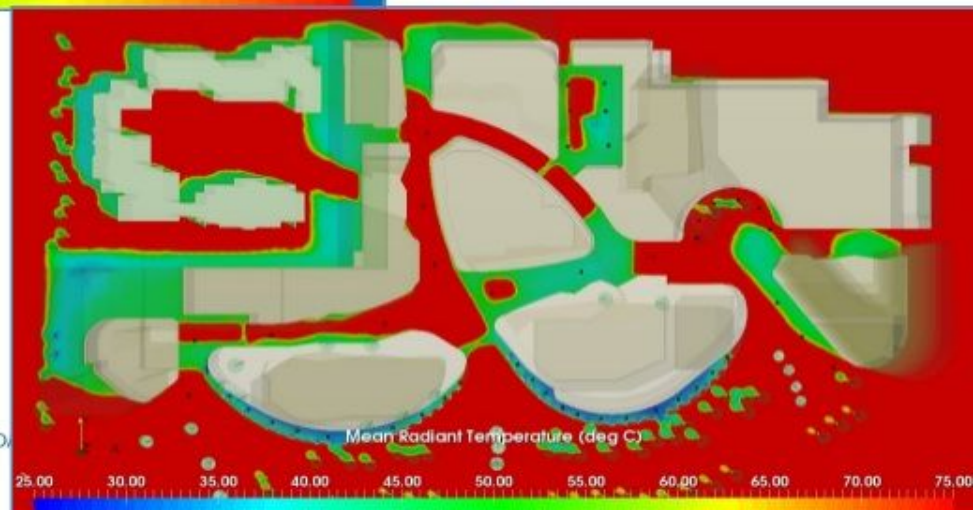
Athaiba Development, Muscat Oman



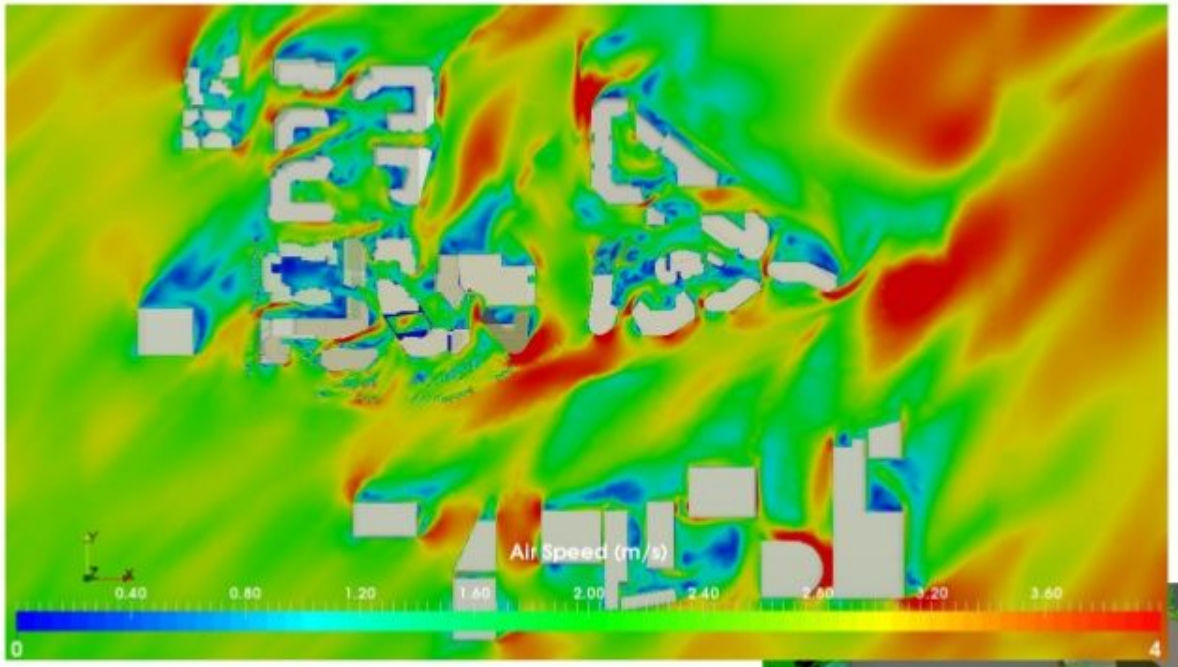


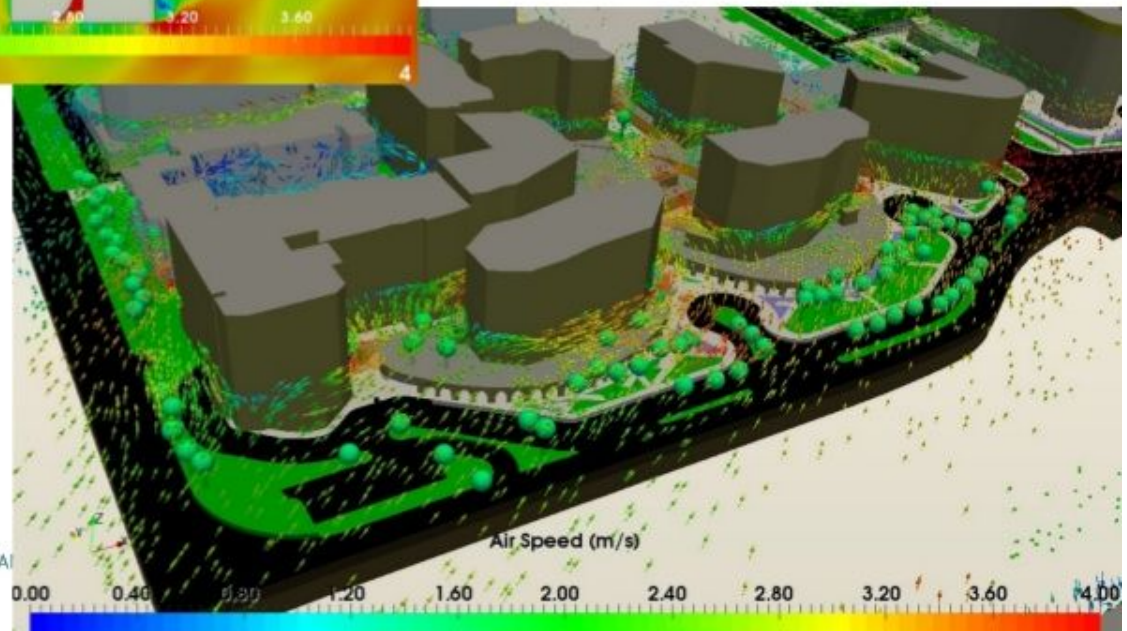
Athaiba Development, Muscat Oman



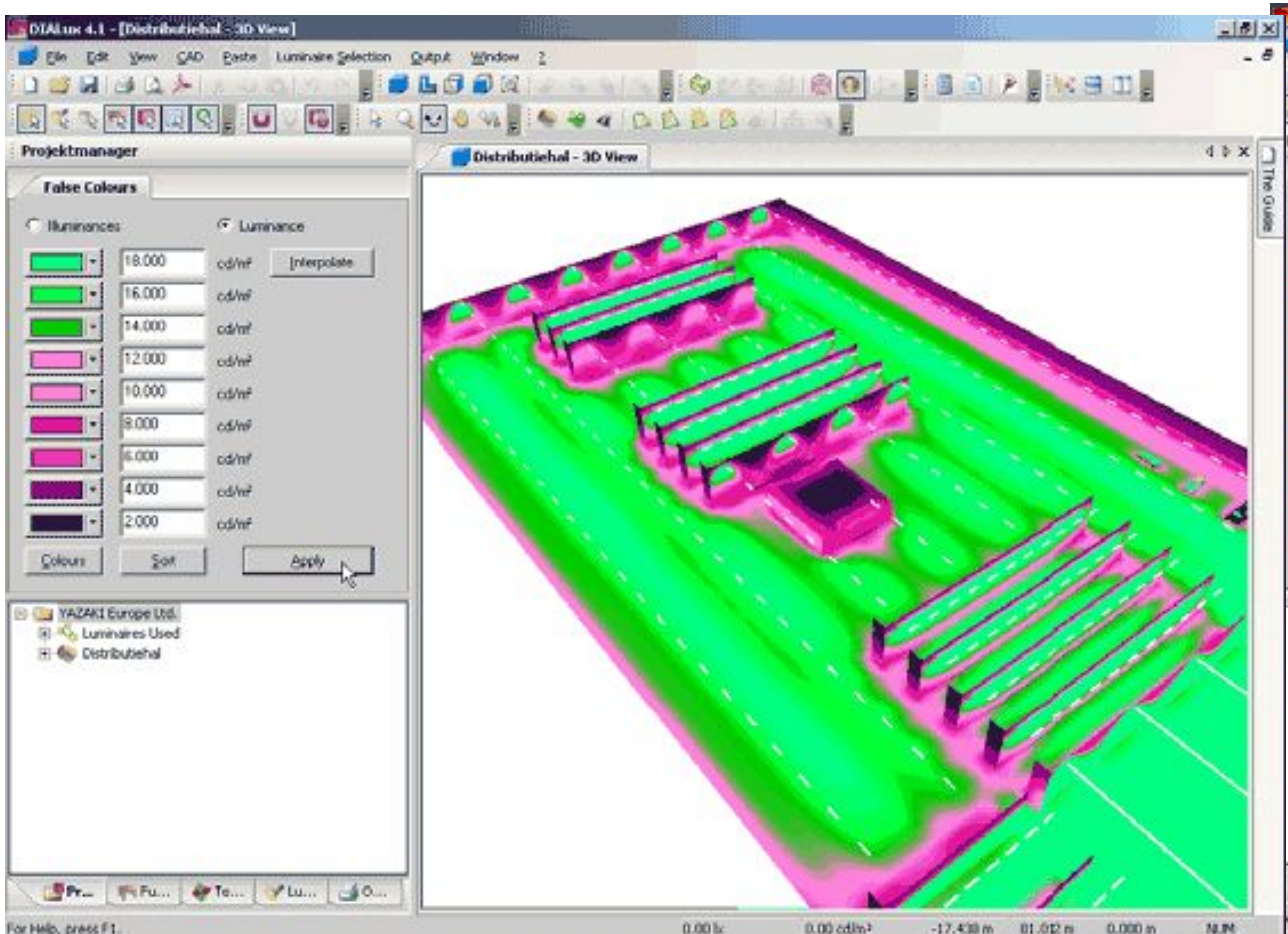


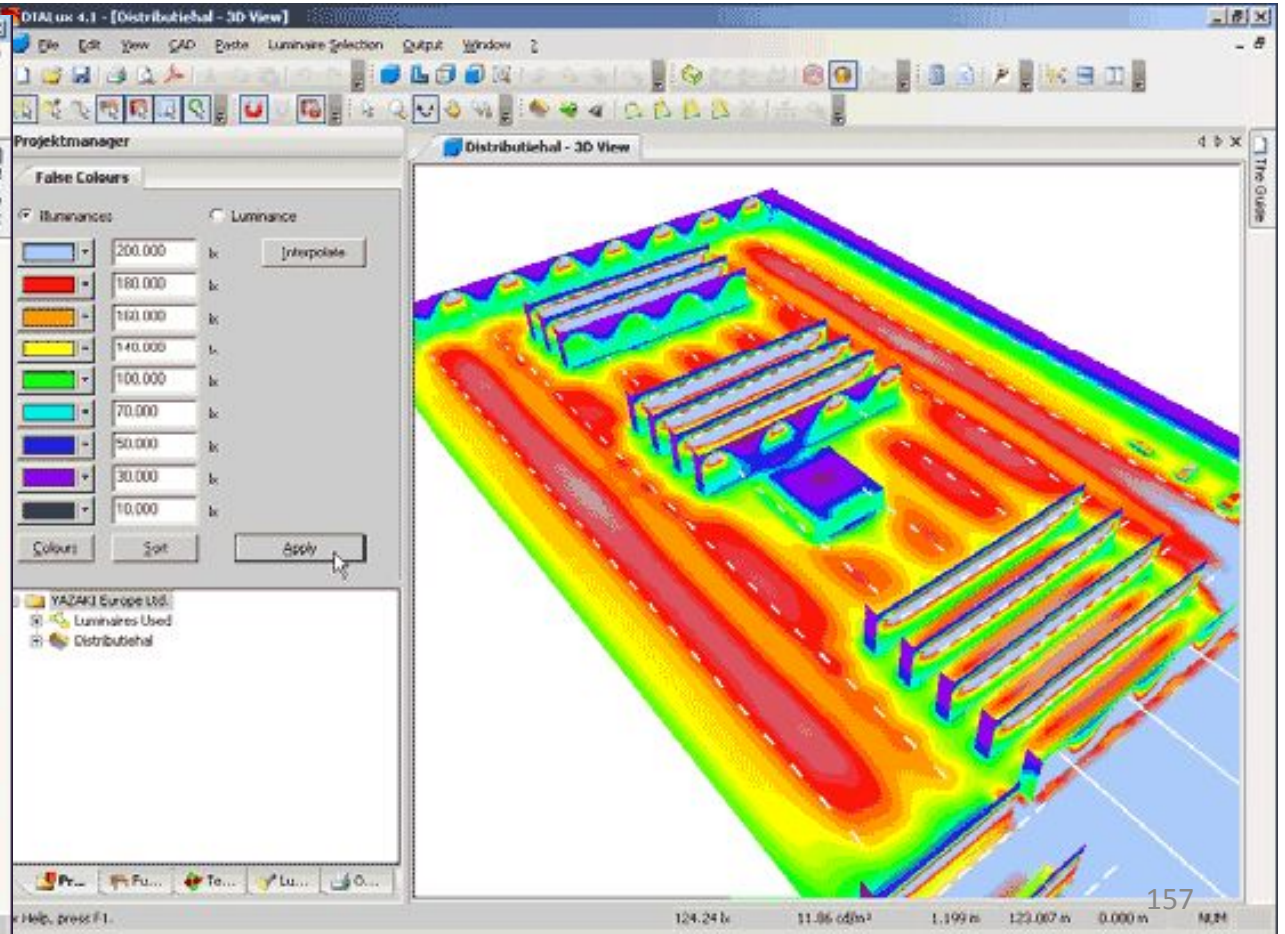
Athaiba Development, Muscat Oman



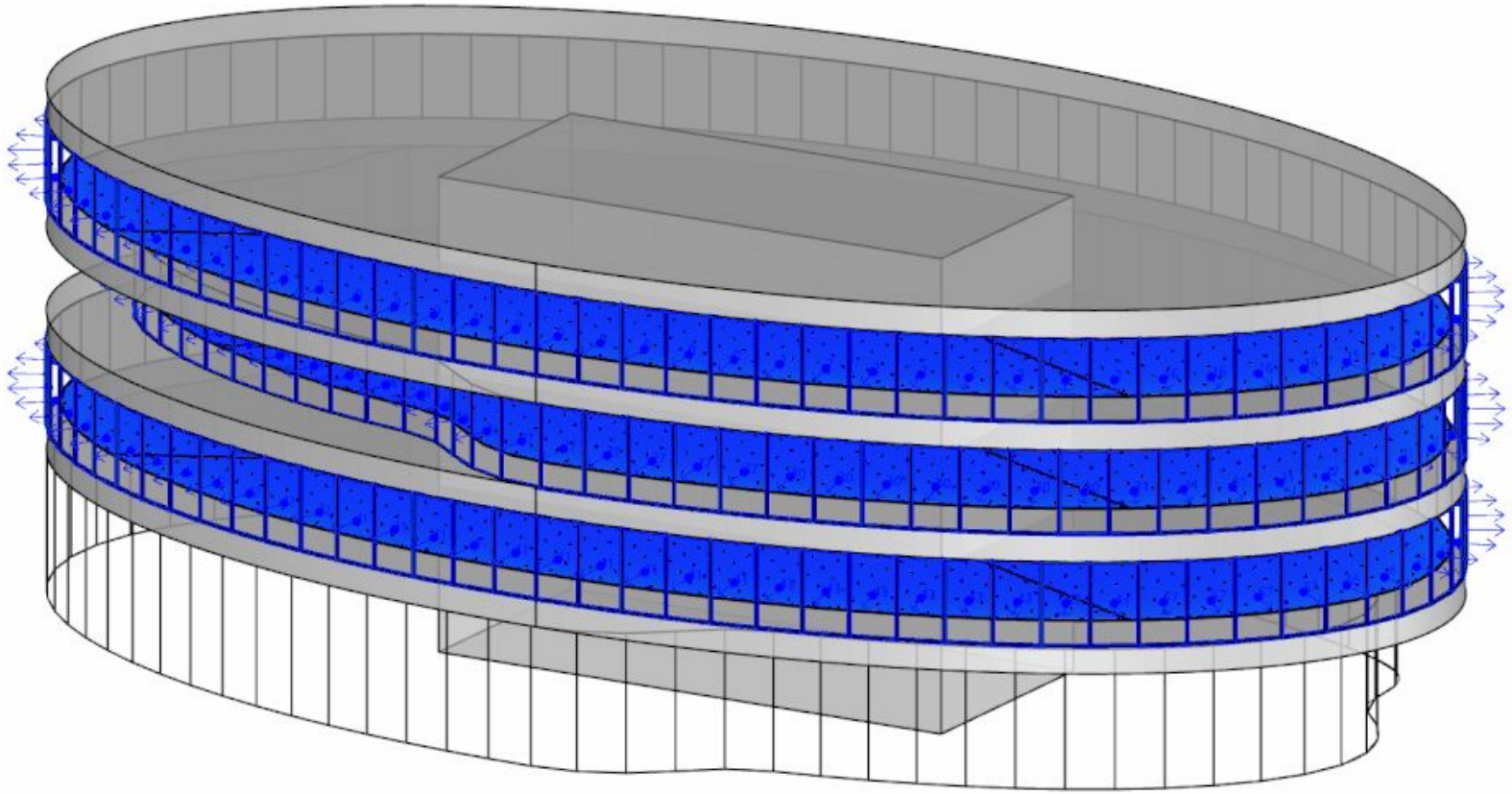


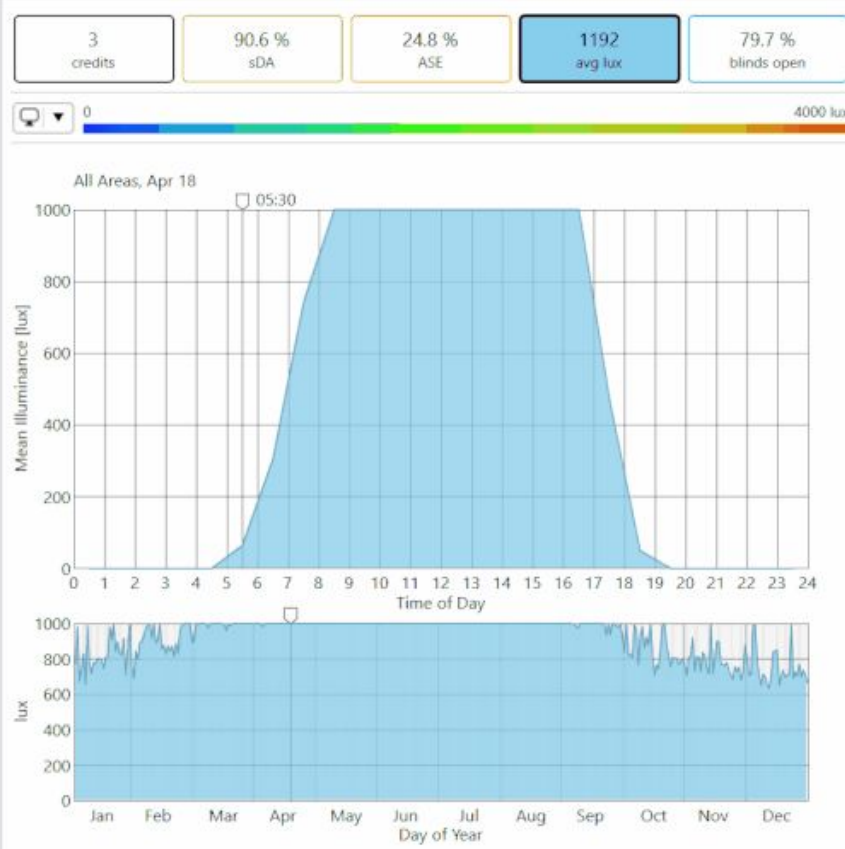
Dialux


DIALux 4.1 - [Distributiehal - 3D View]
Projektmanager
False Colours
Illuminances
Luminance
Interpolate
Colours
Sort
Apply
YAZAKI Europe Ltd.
Luminaires Used
Distributiehal
Distributiehal - 3D View


DIALux 4.1 - [Distributiehal - 3D View]
Projektmanager
False Colours
Illuminances
Luminance
Interpolate
Colours
Sort
Apply
YAZAKI Europe Ltd.
Luminaires Used
Distributiehal
Distributiehal - 3D View

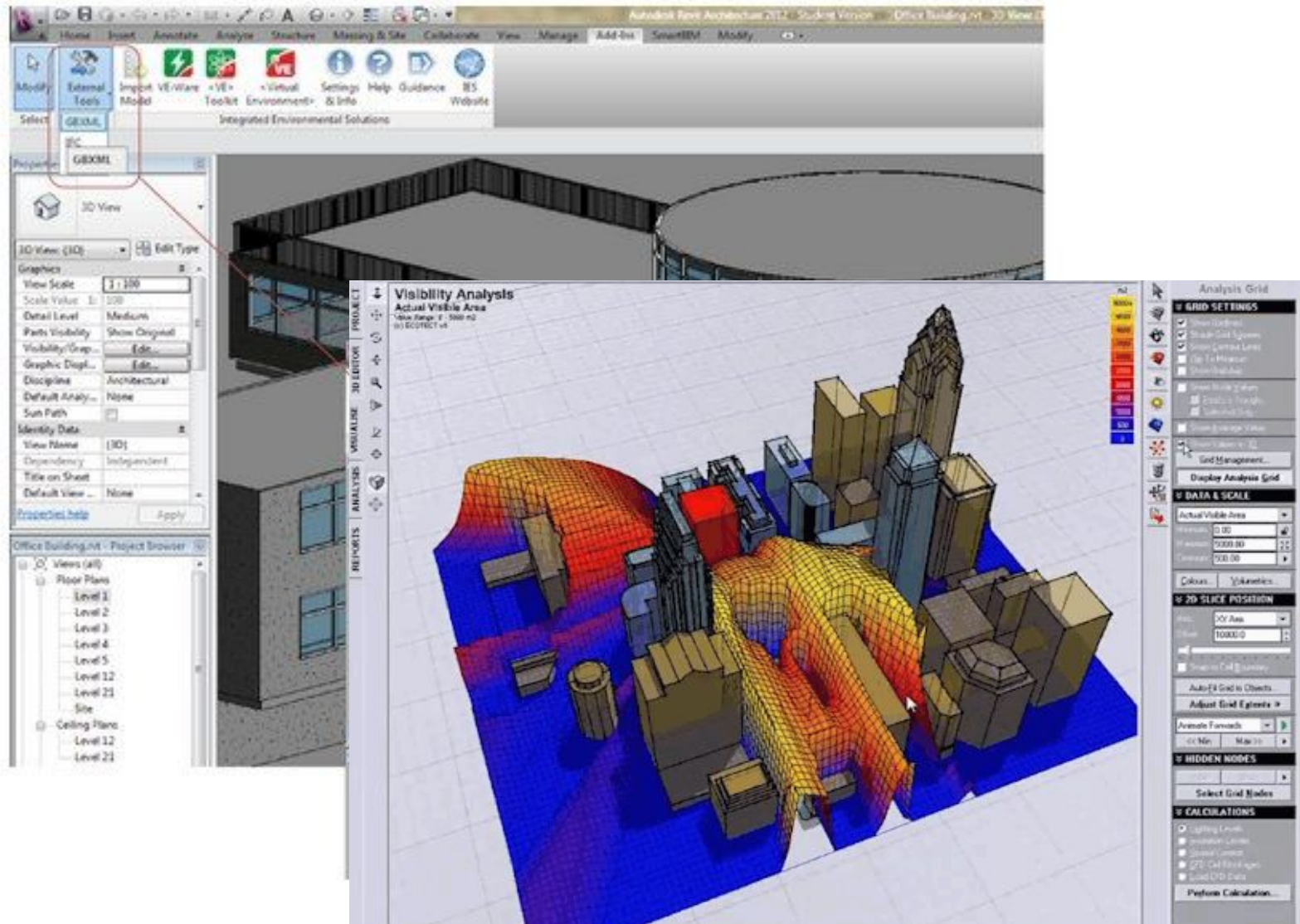
climatestudio





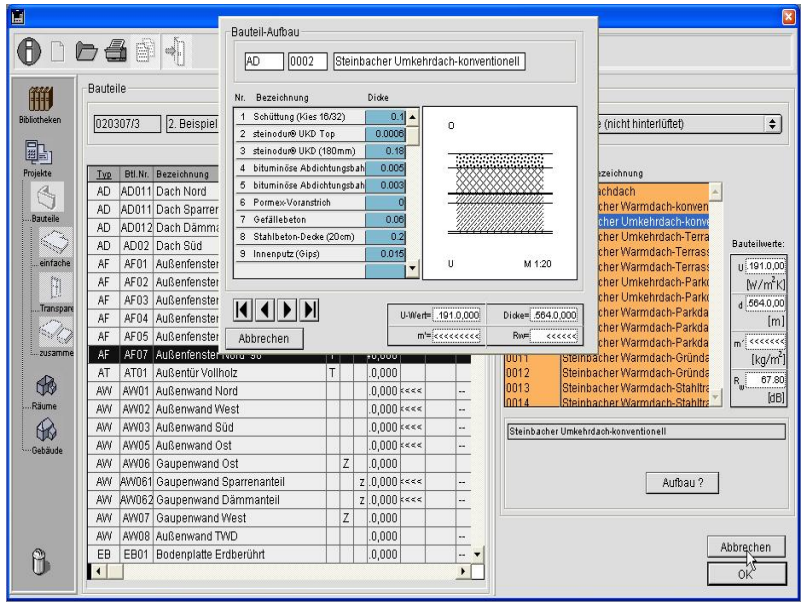
Software

directly transferring BIM model to Ecotect via plug-in based on gbXML file format.



Applications: ArchiPHYSIK

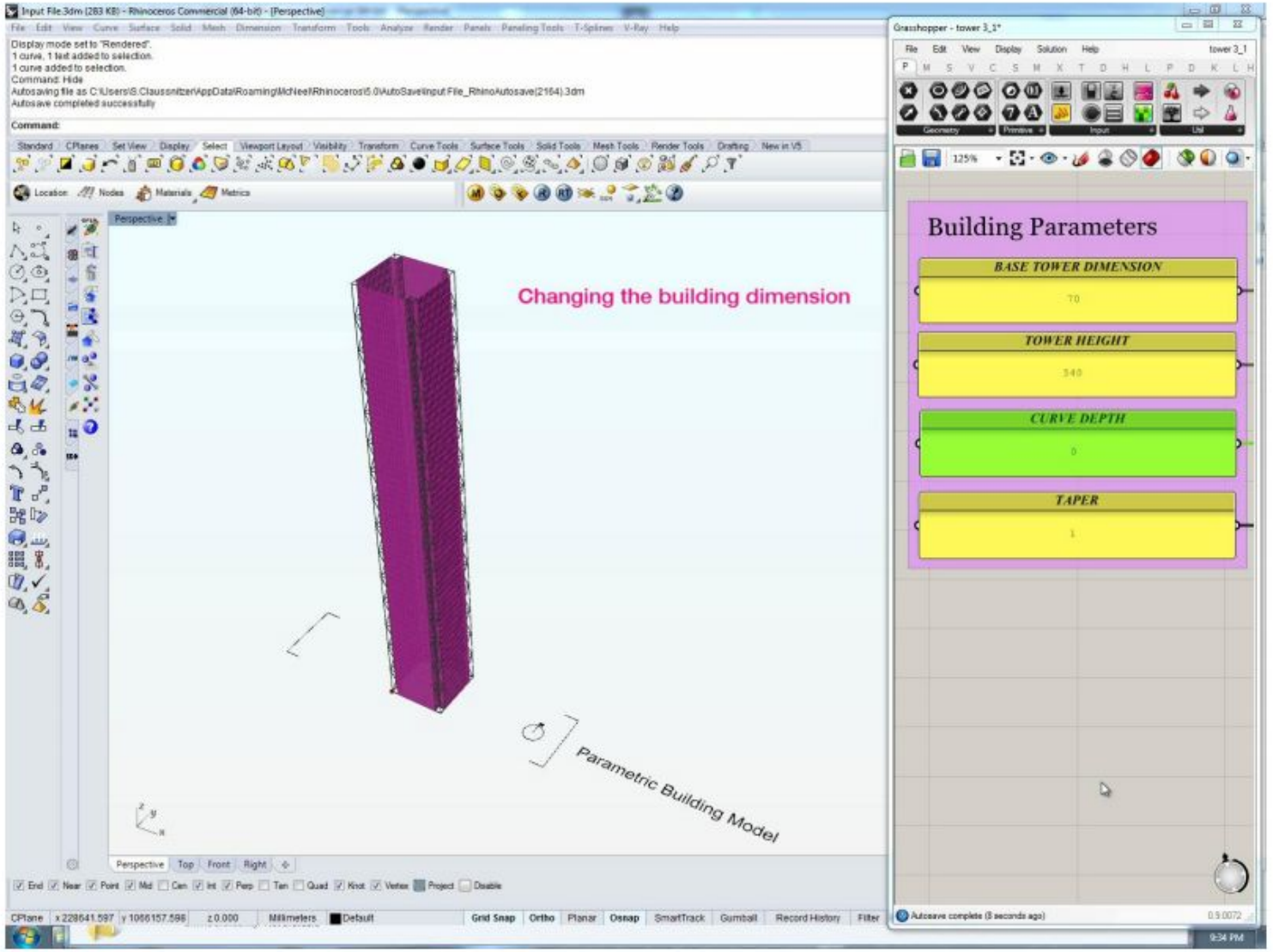
- A complete solution for thermal analysis including U-value, vapor diffusion and temperature amplitudes.
- Identifies failures compared to pre-defined values.
- Building performance
- Building component performance



https://archiphysik.at/

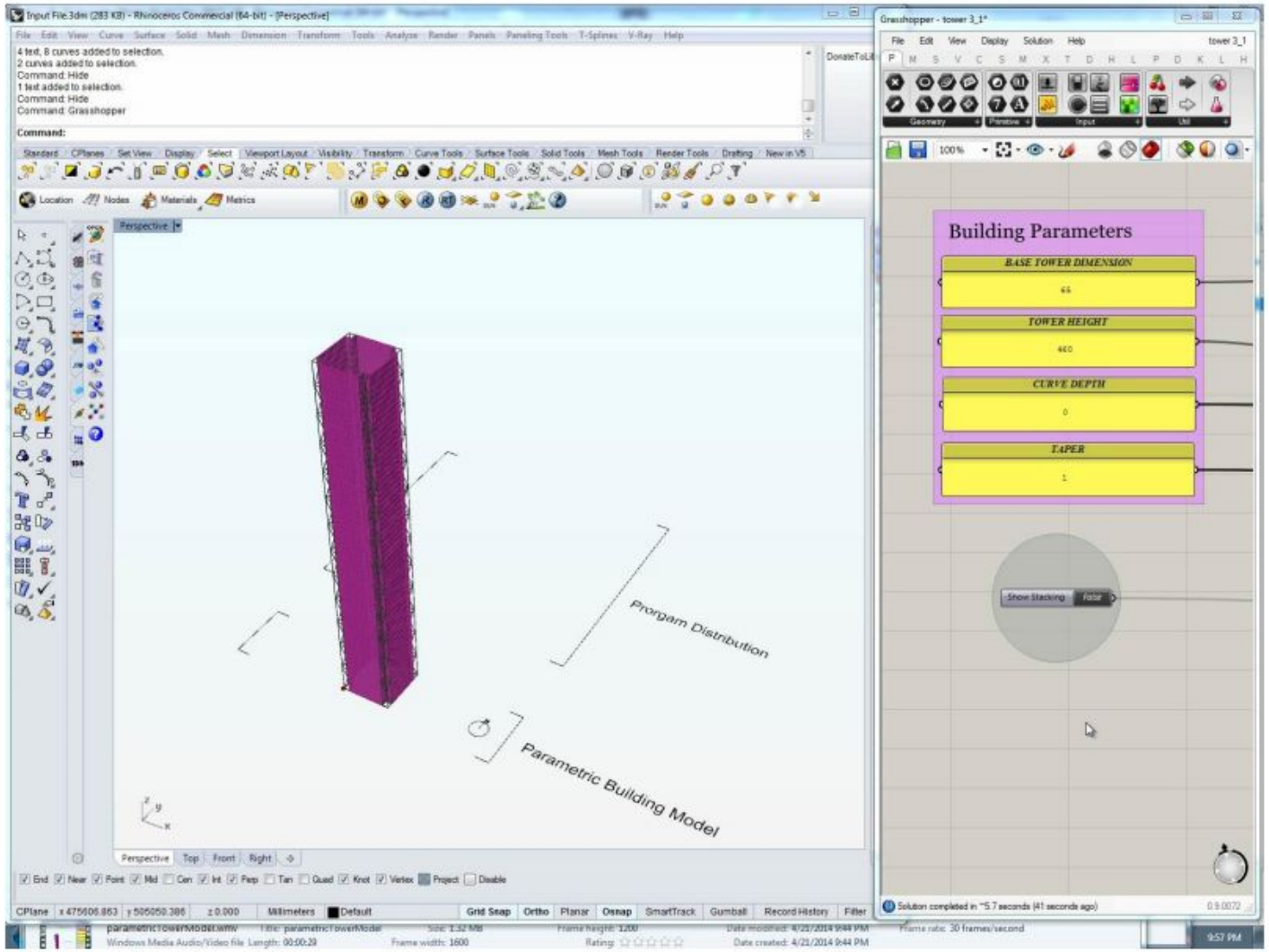
Rhino
Grasshopper

INTEGRATED DESIGN INTENT



PARAMETRIC BUILDING MODEL WITH ENCODED DESIGN INTENT

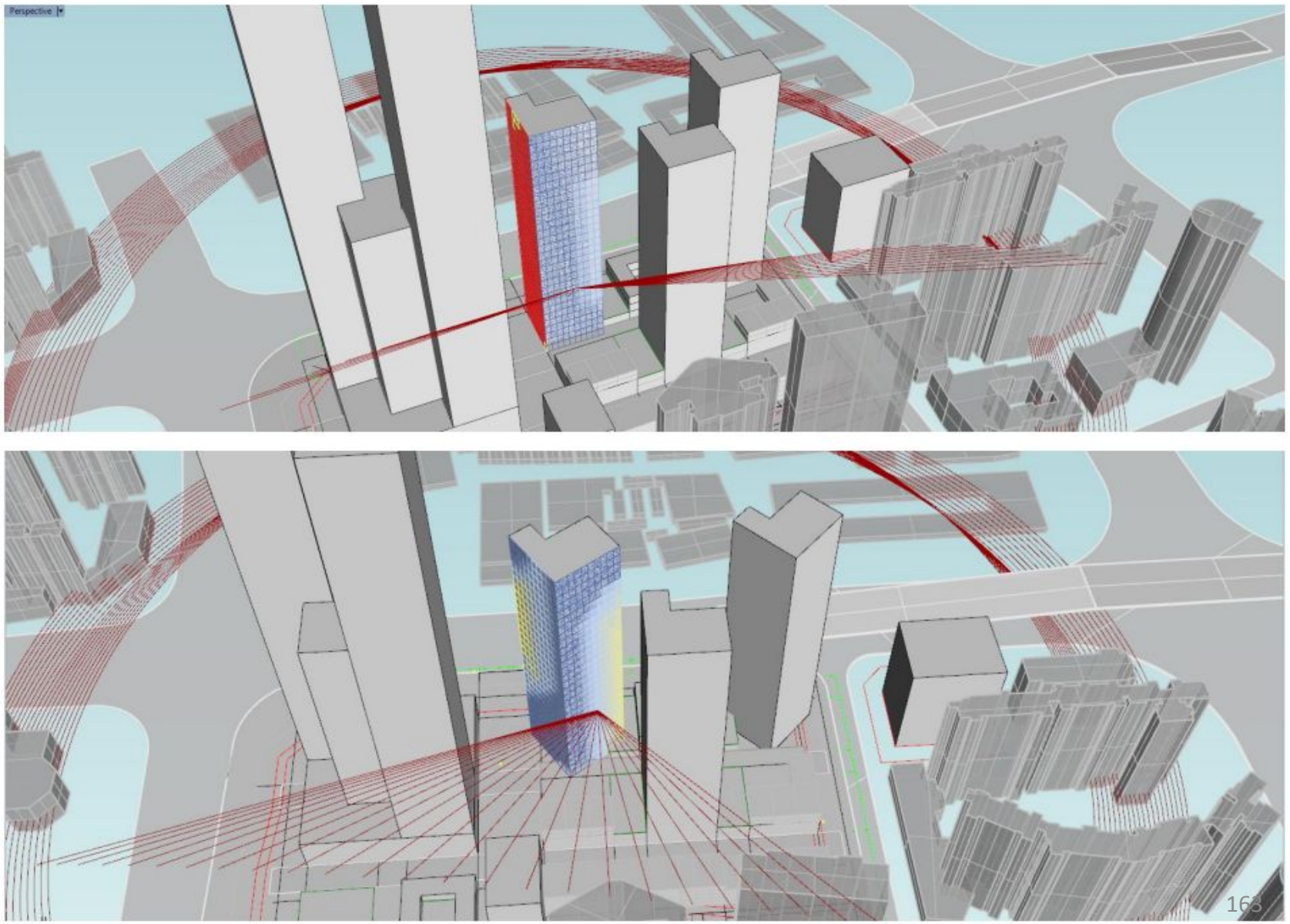
INTEGRATED DATA MODEL
PROGRAM VALIDATION



PARAMETRIC BUILDING MODEL UNDERSTANDS PLANING CONSTRAINTS

INTEGRATED DATA MODEL

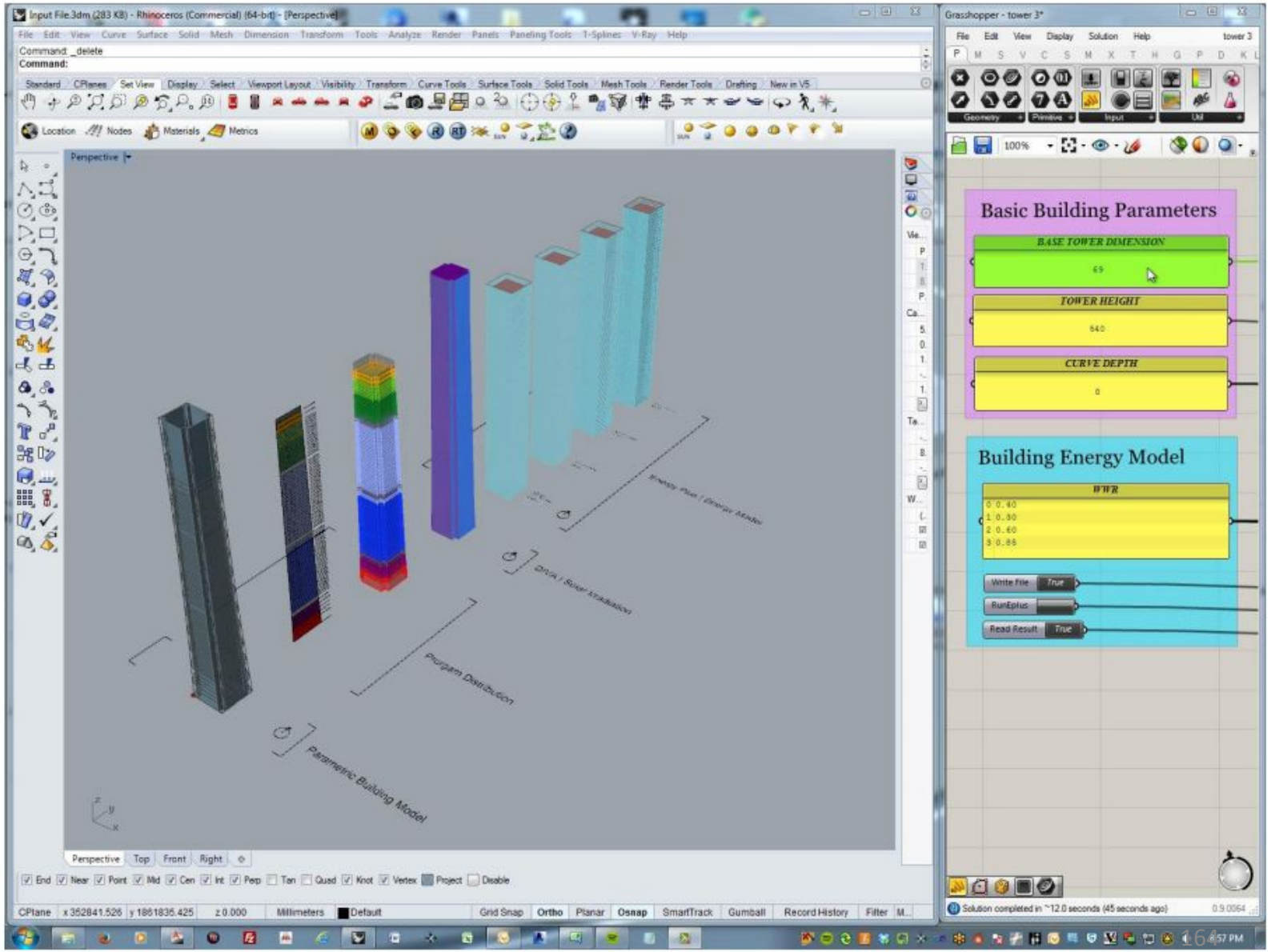
CODE CHECKING



Software

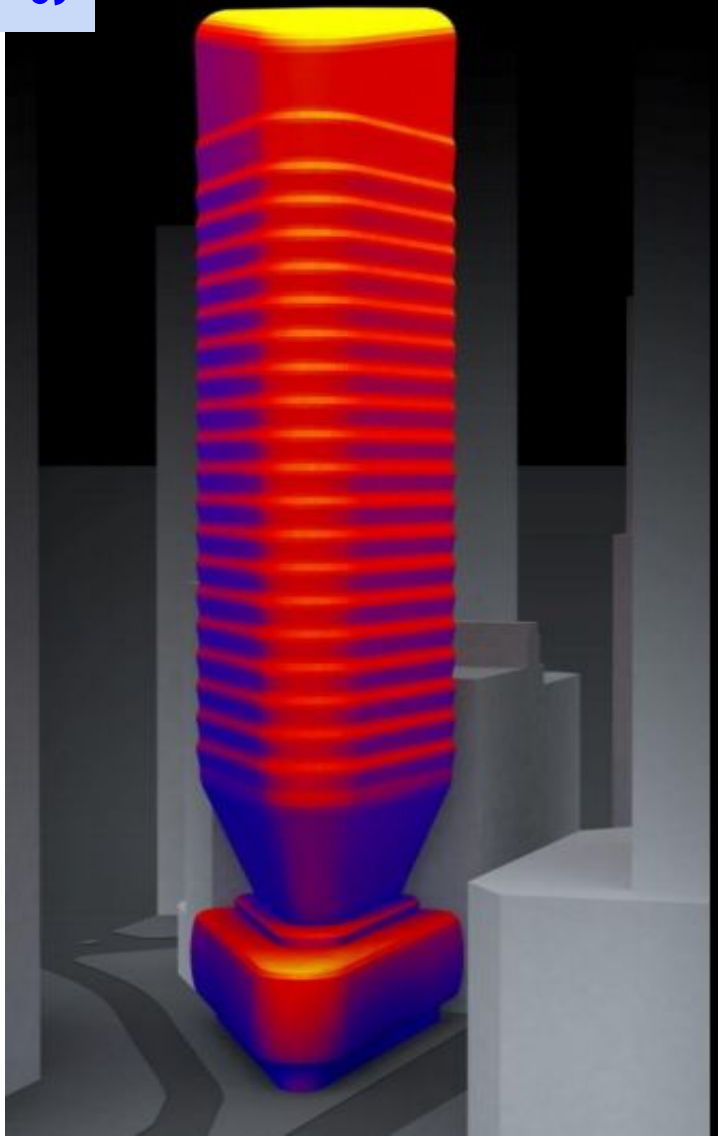
INTEGRATED DATA MODEL

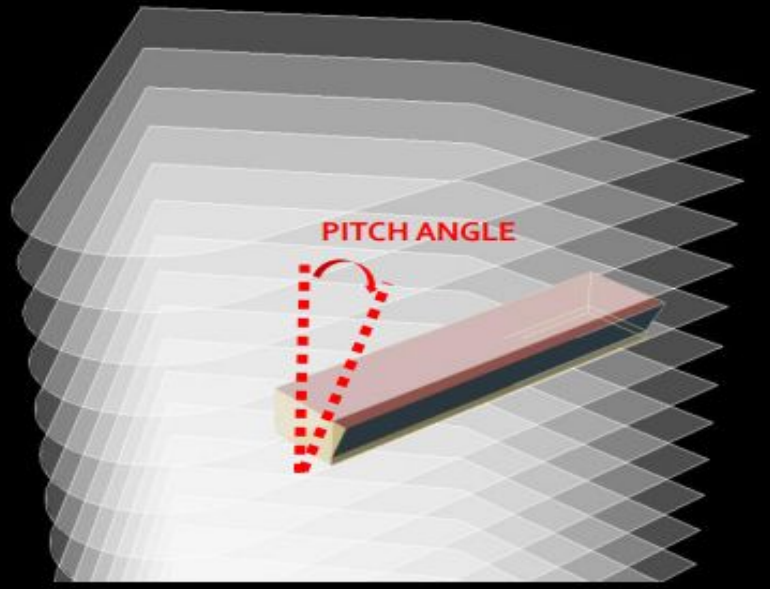
INTEGRATED ENVIRONMENTAL ANALYSIS

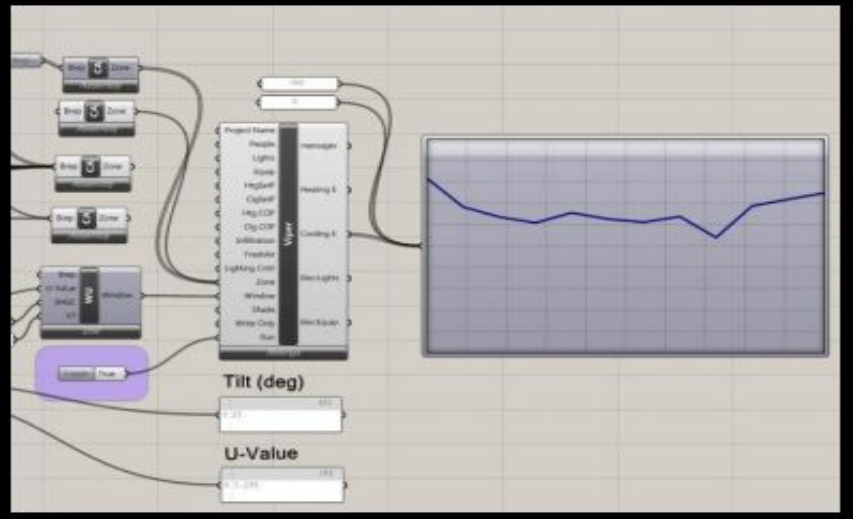


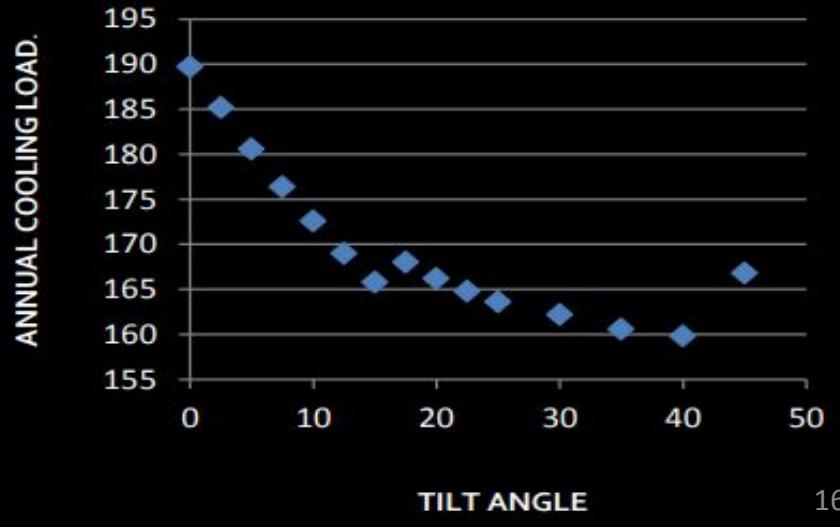
INTEGRATED DATA MODEL

PARAMETRIC ENERGY ANALYSIS



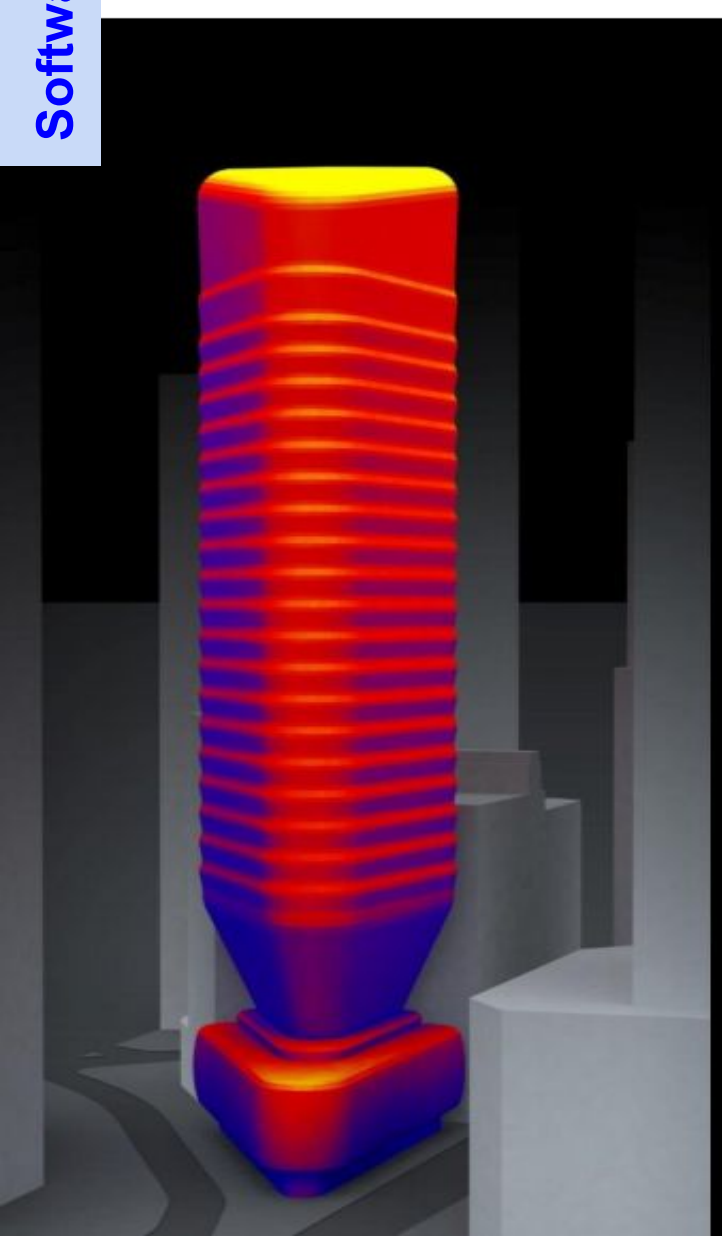


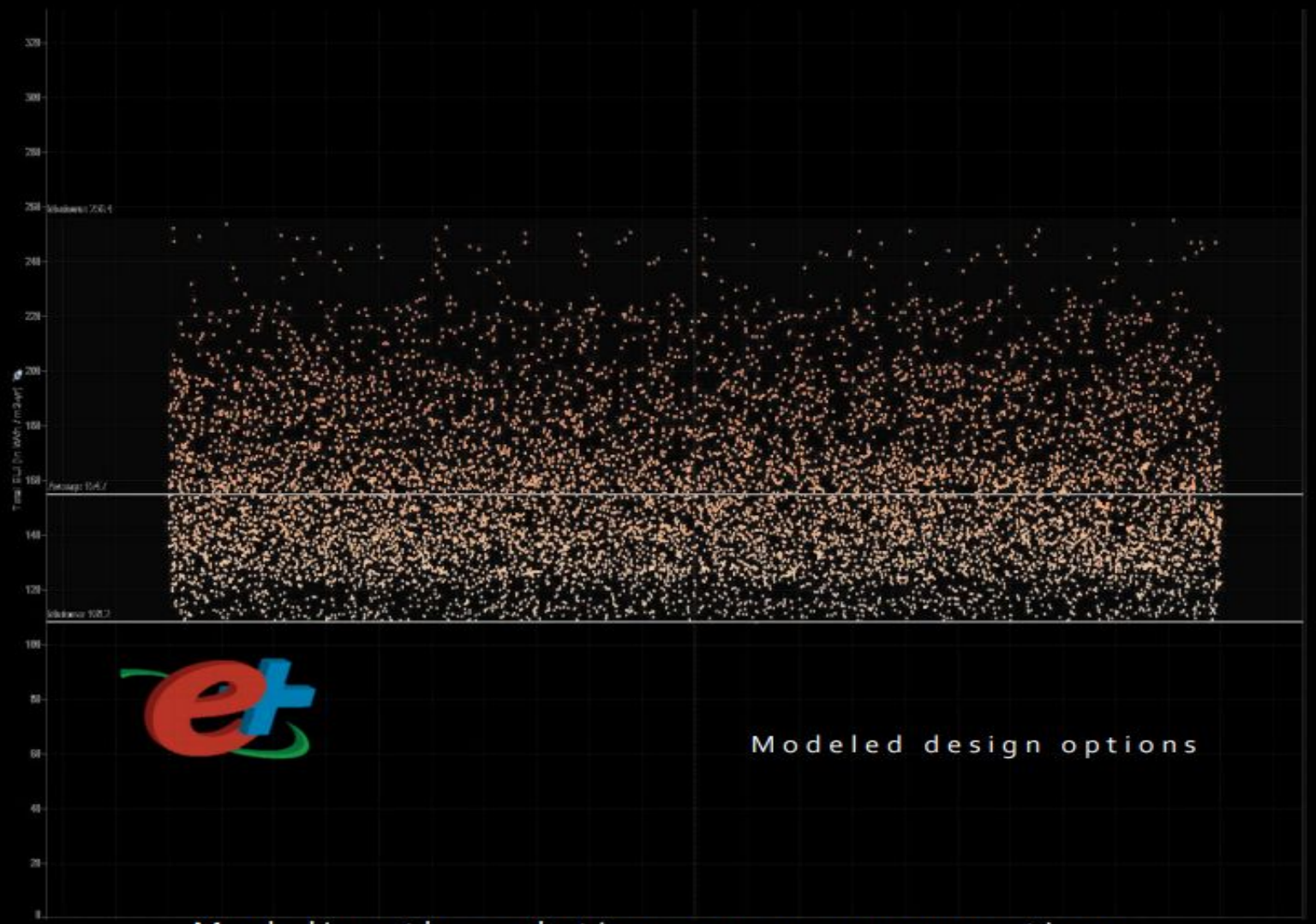




INTEGRATED DATA MODEL

PARAMETRIC ENERGY ANALYSIS

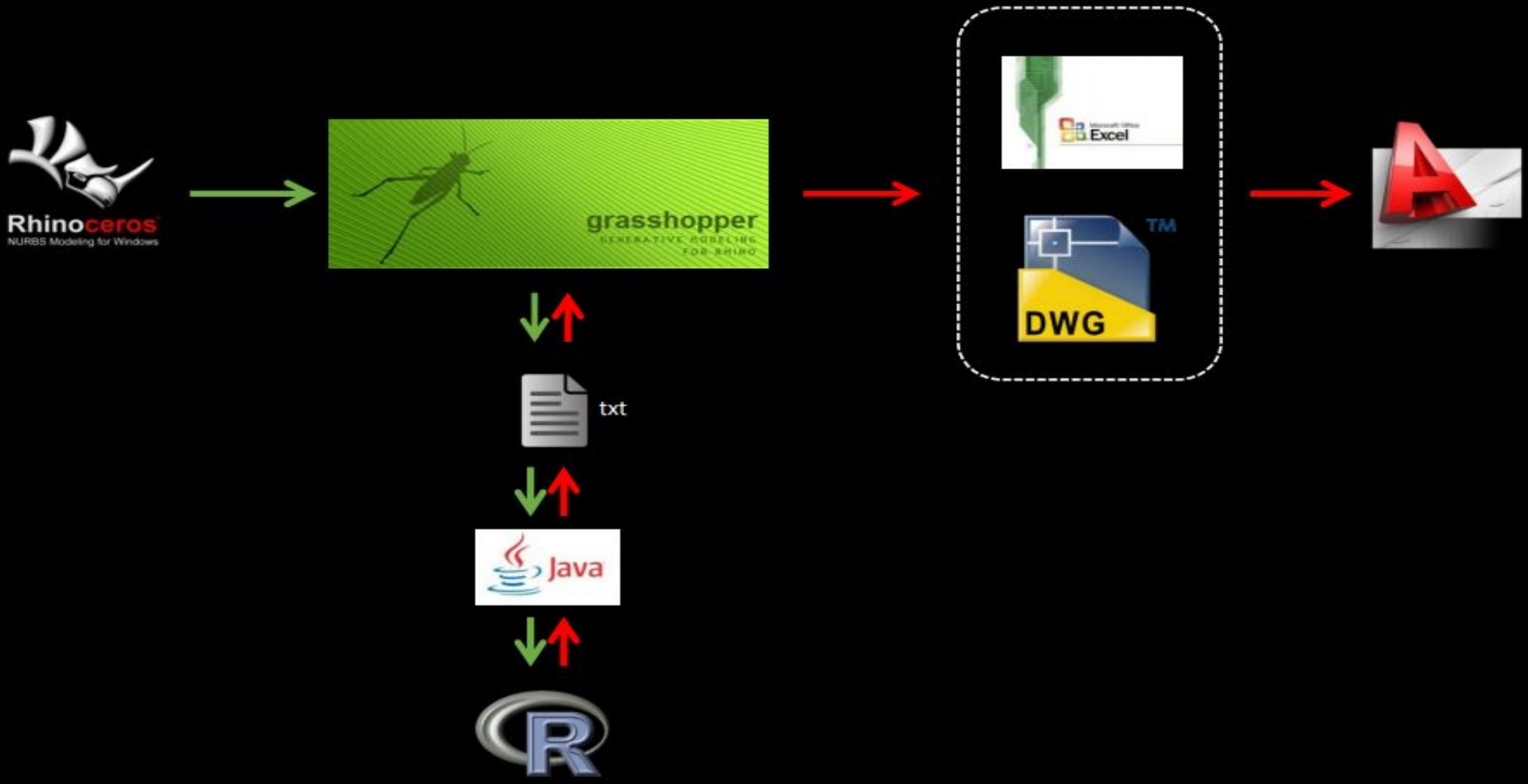




Modeling the solution space ~9,000 options

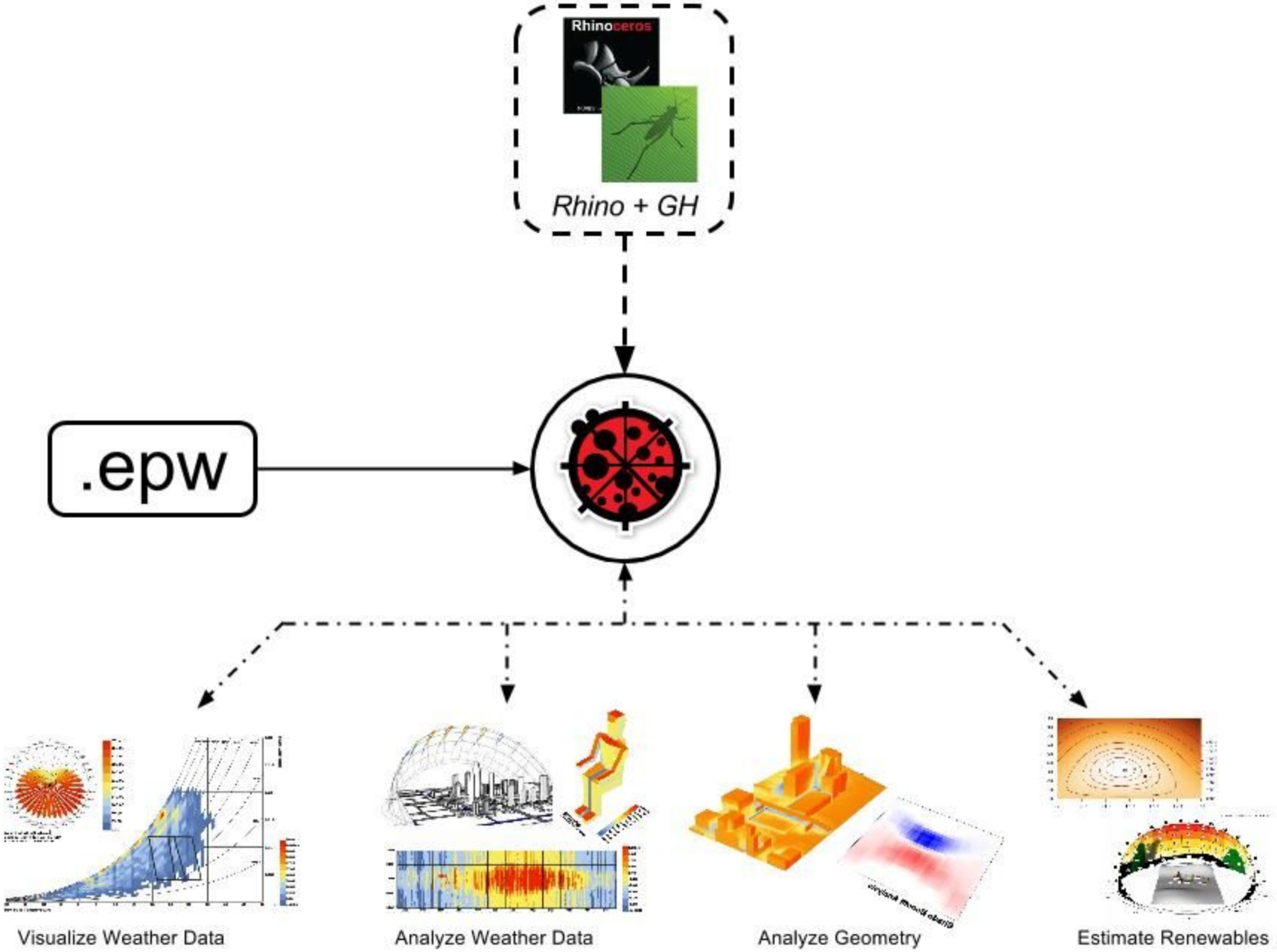
INTEGRATED DATA MODEL

DATA INTER-PLATFORM COLLABORATION



ladybug

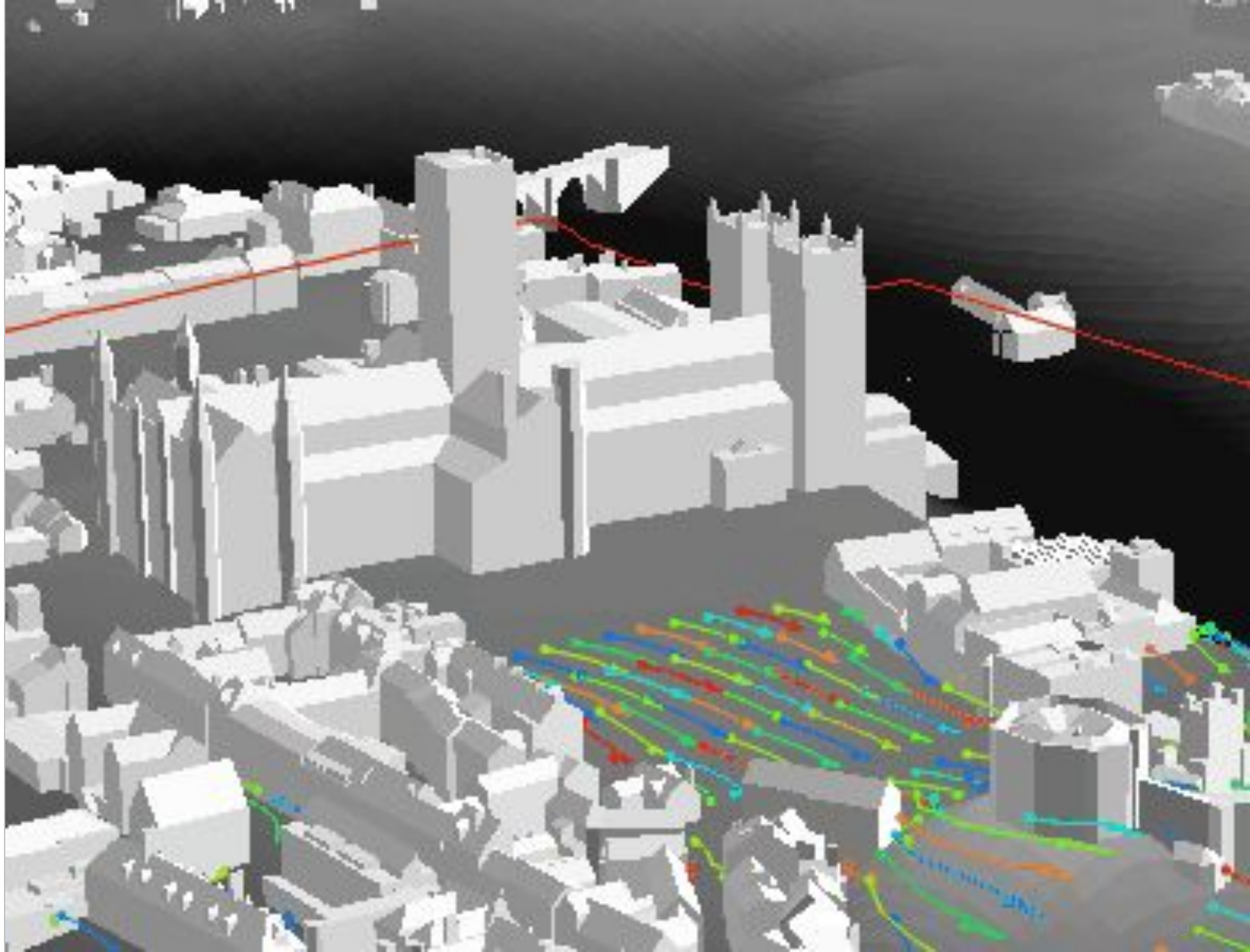
Ladybug allows you to import and analyze standard weather data in Grasshopper; draw diagrams like Sun-path, wind-rose, radiation-rose, etc; customize the diagrams in several ways; run radiation analysis, shadow studies, and view analysis.



Software

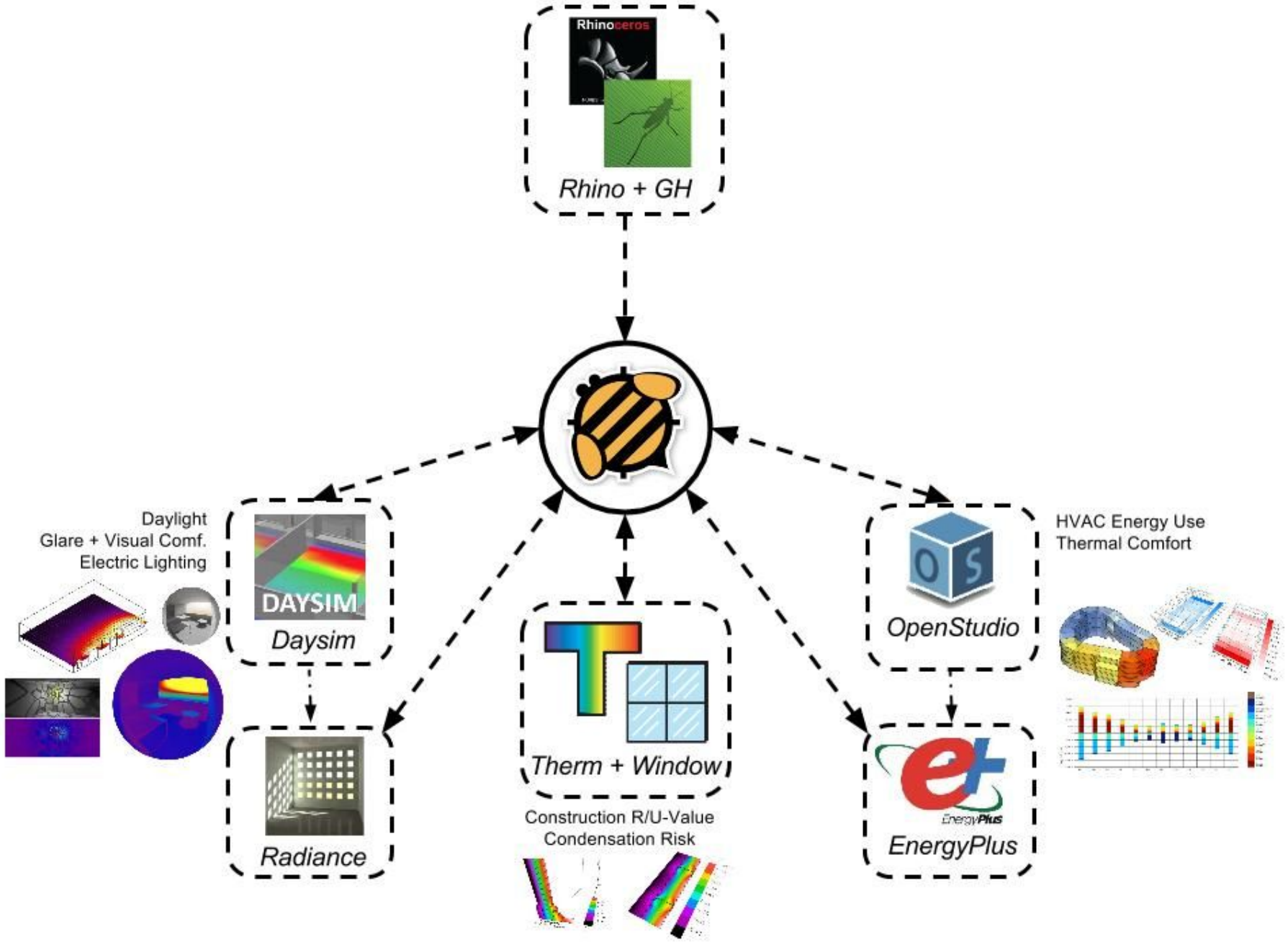
Butterfly

Butterfly is a Grasshopper/Dynamo plugin and object-oriented python library that creates and runs computational fluid dynamics (CFD) simulations using OpenFOAM.

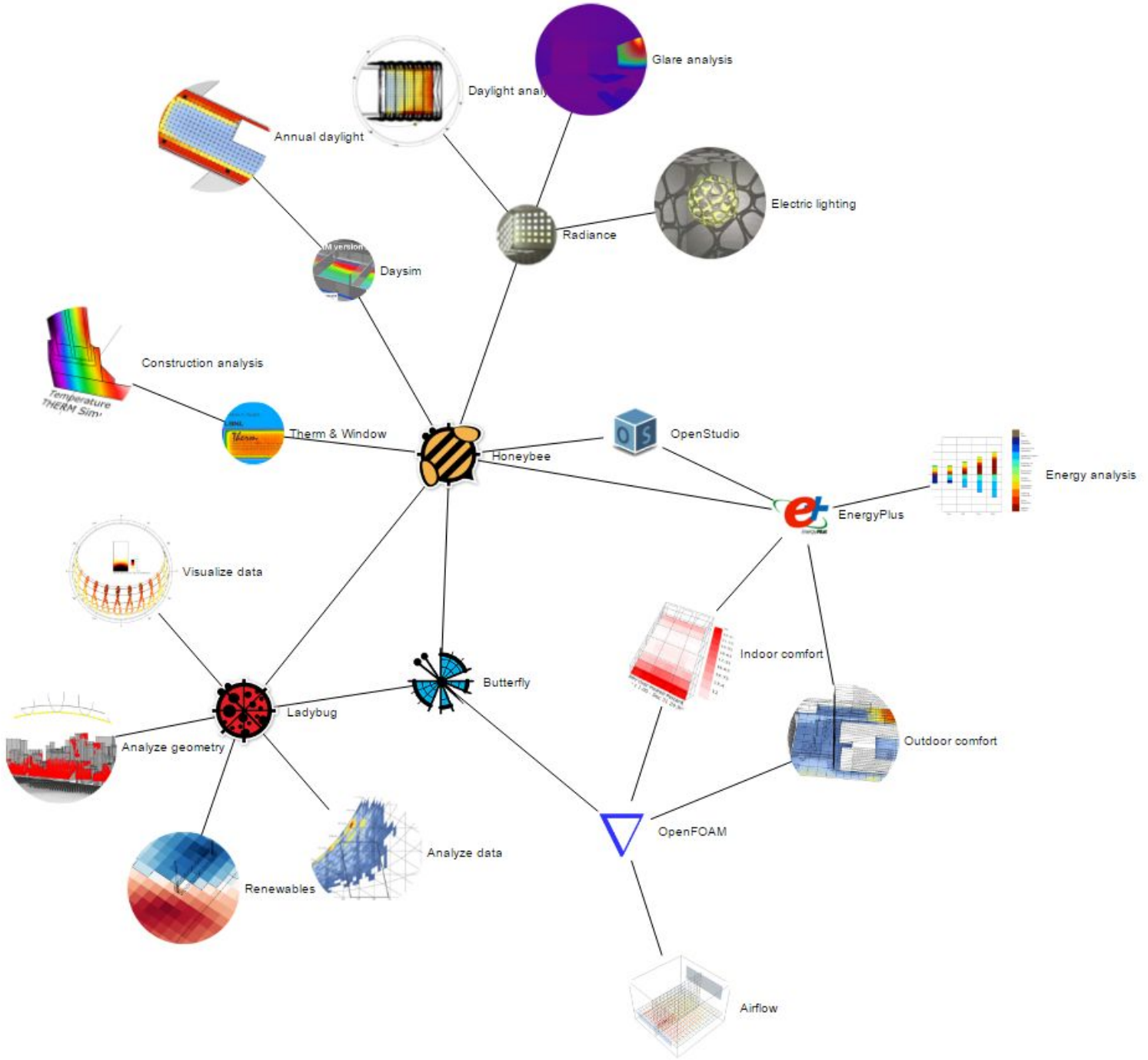


Honeybee

Honeybee connects Grasshopper3D to validated simulation engines such as EnergyPlus, Radiance, Daysim and OpenStudio for building energy, comfort, daylighting and lighting simulation.

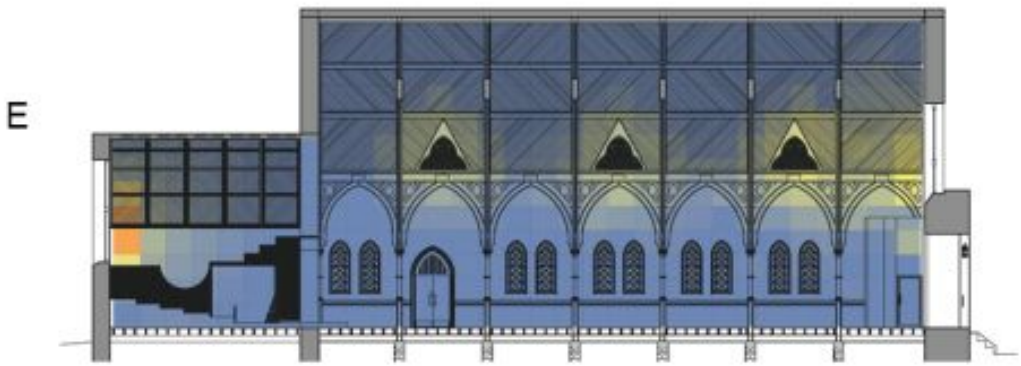


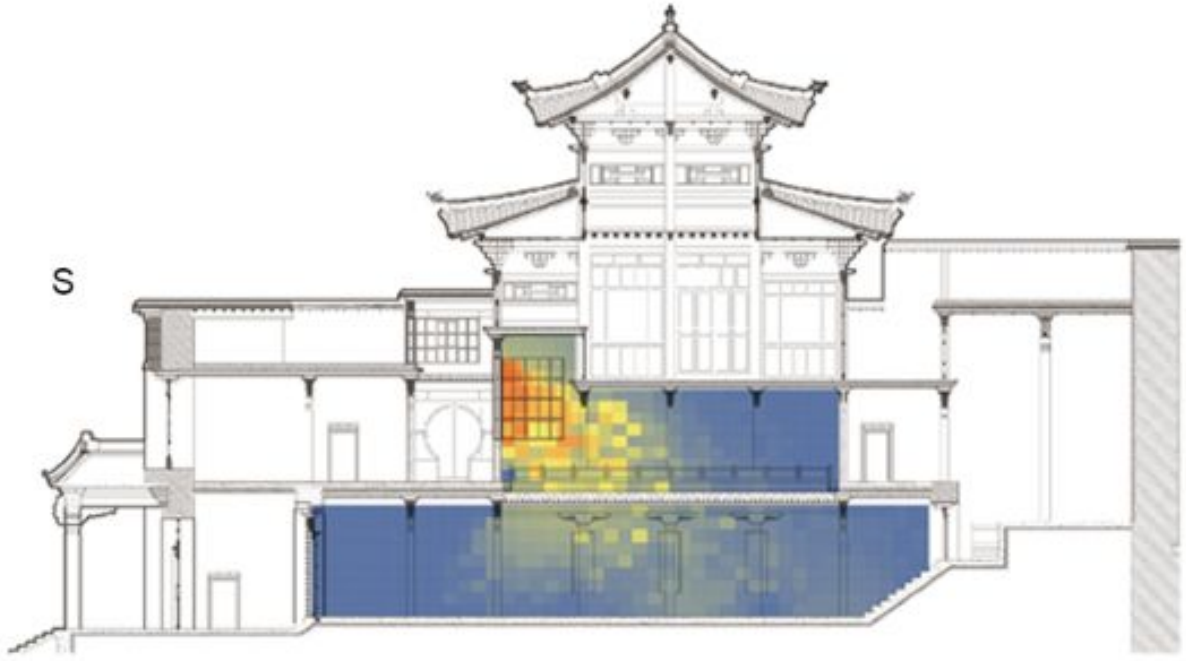
Software


Glare analysis
Daylight anal
Annual daylight
Electric lighting
Radiance
Daysim
Construction analysis
Therm & Window
Honeybee
OpenStudio
Energy analysis
EnergyPlus
Visualize data
Indoor comfort
Butterfly
Ladybug
Outdoor comfort
Analyze geometry
OpenFOAM
Analyze data
Renewables
Airflow

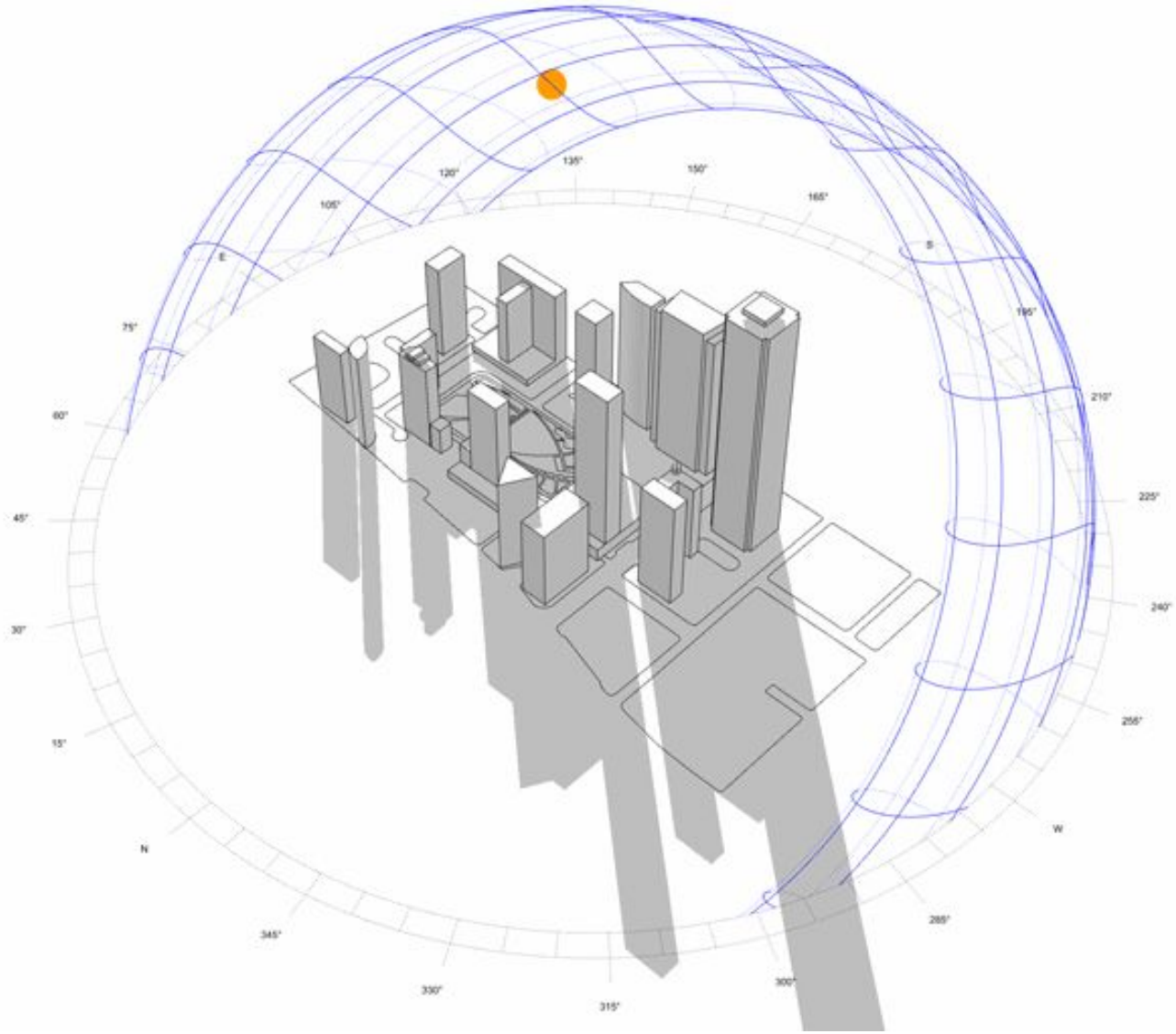
DIVA-for-Rhino

- Point in Time Visualization
- Daylight Factor
- Illuminance Distribution
- LEED Compliance
- Radiation Maps
- Spatial Daylight Autonomy
- Annual Solar Exposure

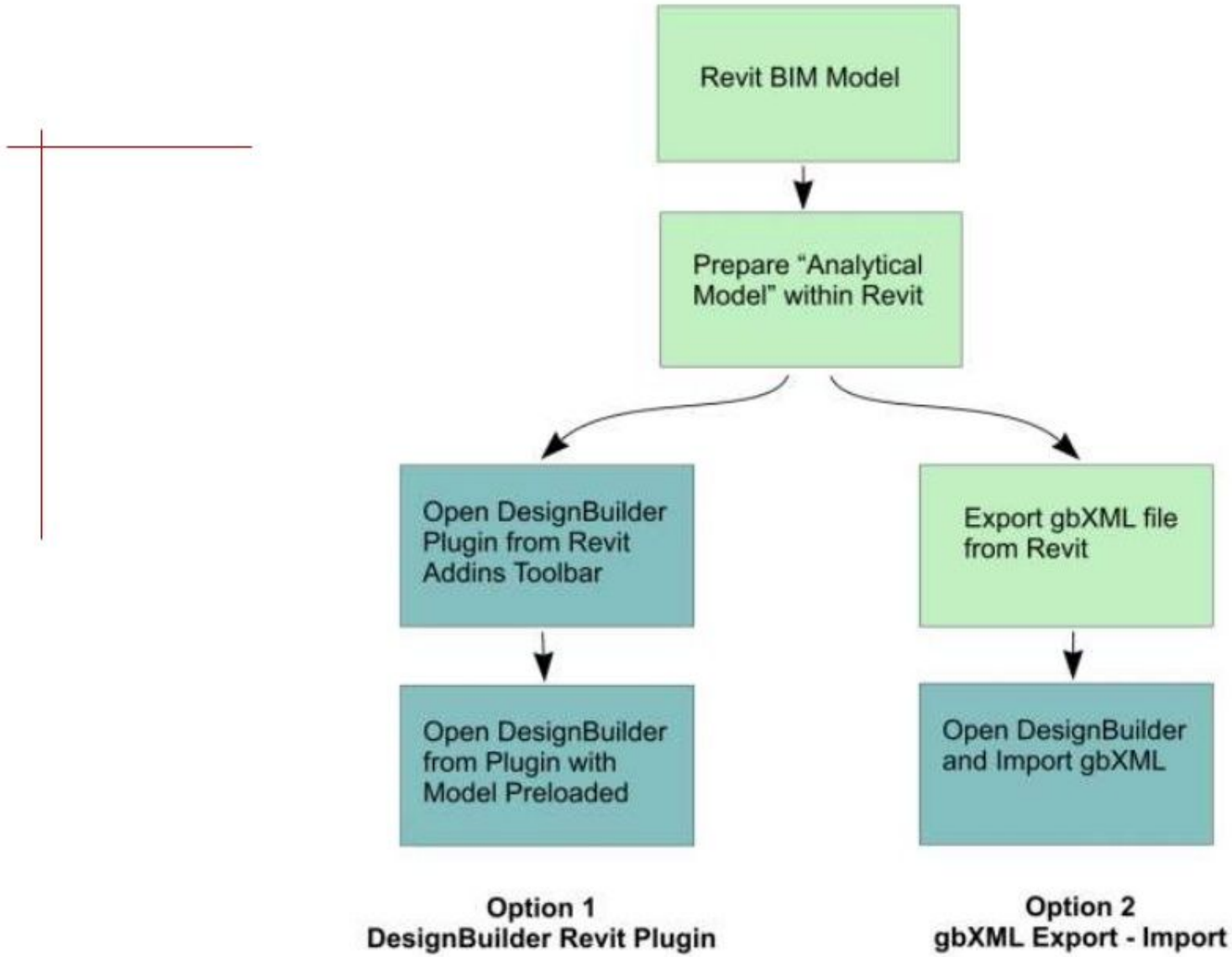




DIVA-for-Rhino

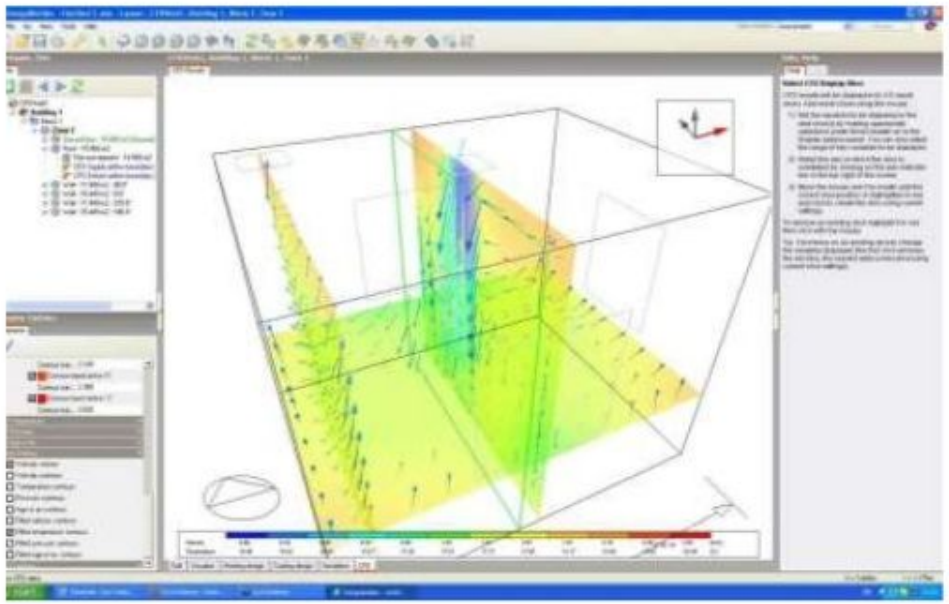


Exporting Revit Models to DesignBuilder



DesignBuilder

DesignBuilder, a whole building energy use analysis simulation tool, is the oldest, easiest to use, most powerful graphical user interface to EnergyPlus available and includes ASHRAE 90.1 Appendix G Baseline HVAC System templates, materials, and construction libraries



◆http://www.designbuilder.co.uk/

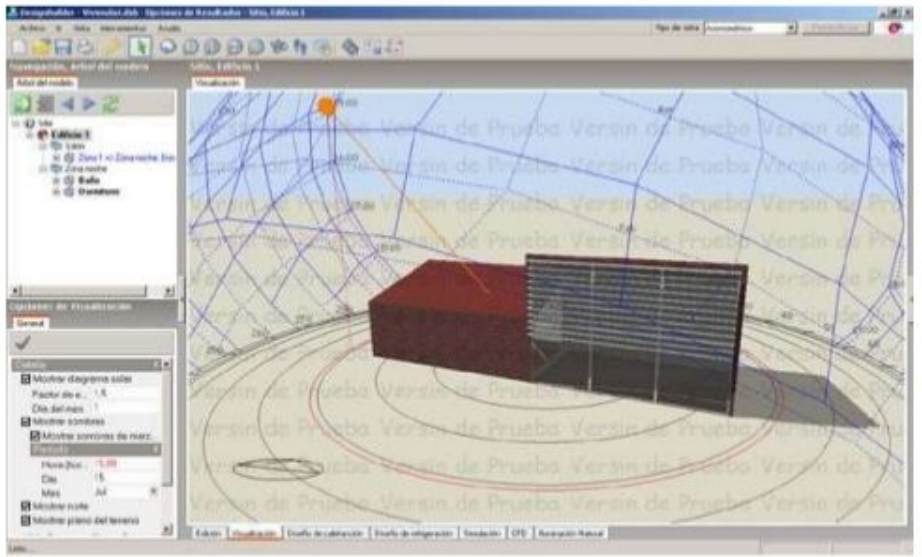
Note : This is good since we can change some or all input parameters and do more in-depth analysis, but it is bad for anyone who is not aware of the complexities of energy simulations. Plus you lose the ability to quickly compare different options within Revit.

41

DesignBuilder Packages for Architects

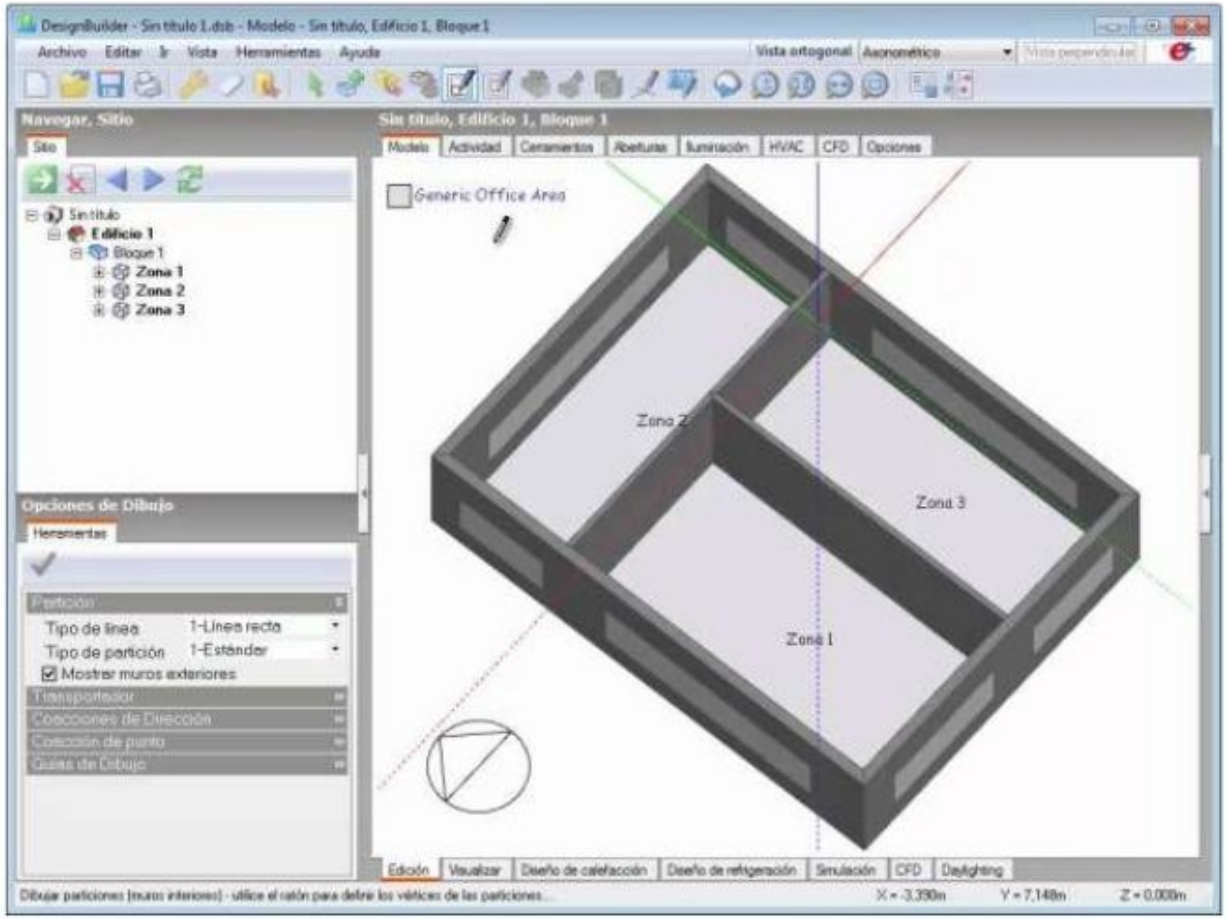
Solar calculations

- The Architectural simulation packages allow you to link with BIM solutions, analyse solar shading, maximise the use of renewable technologies and test facade options all in one place, adjusting as you go according to client requirements.
- High quality technical and rendered outputs help communicate findings to clients in a way they can easily understand. Key performance indicators such as energy consumption, carbon emissions, thermal comfort, daylight availability and cost can be provided throughout the design process in both naturally ventilated and air-conditioned buildings.



DesignBuilder Packages for Architects

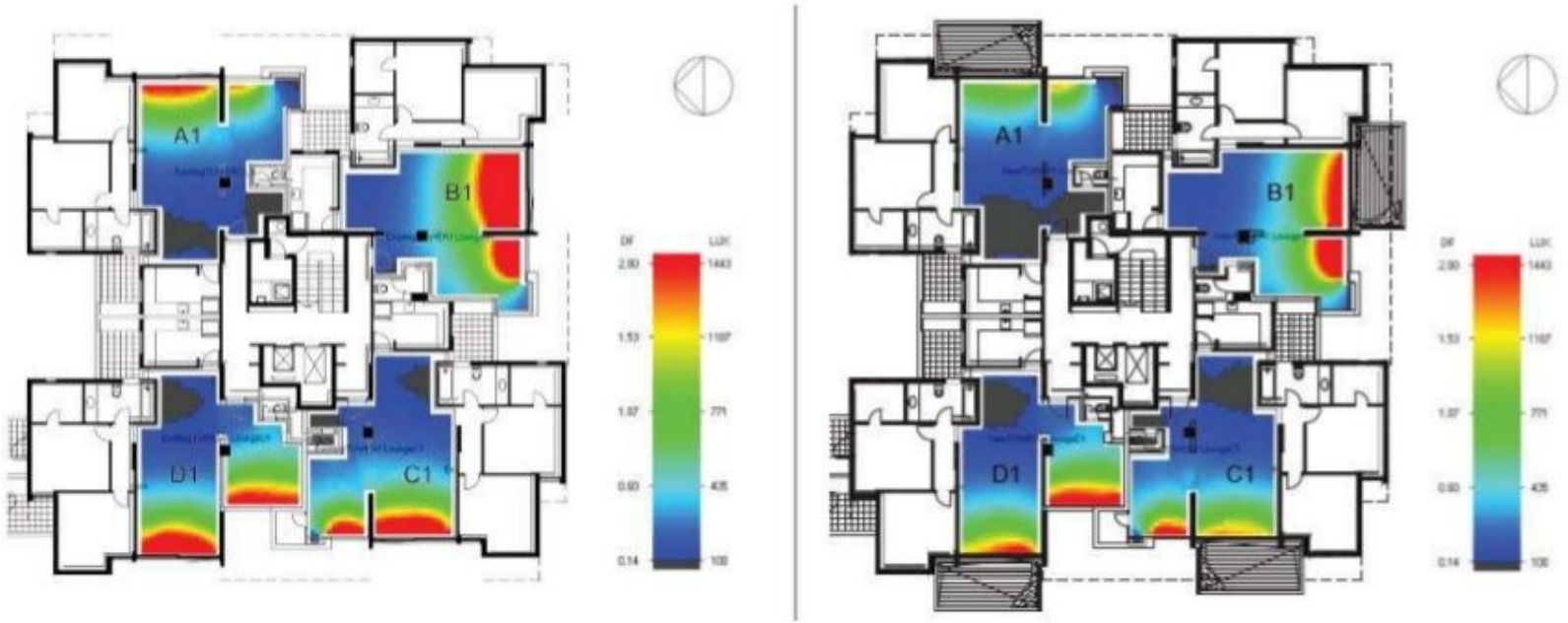
Interactive rendered views, shading and walk-throughs



DesignBuilder Packages for Architects

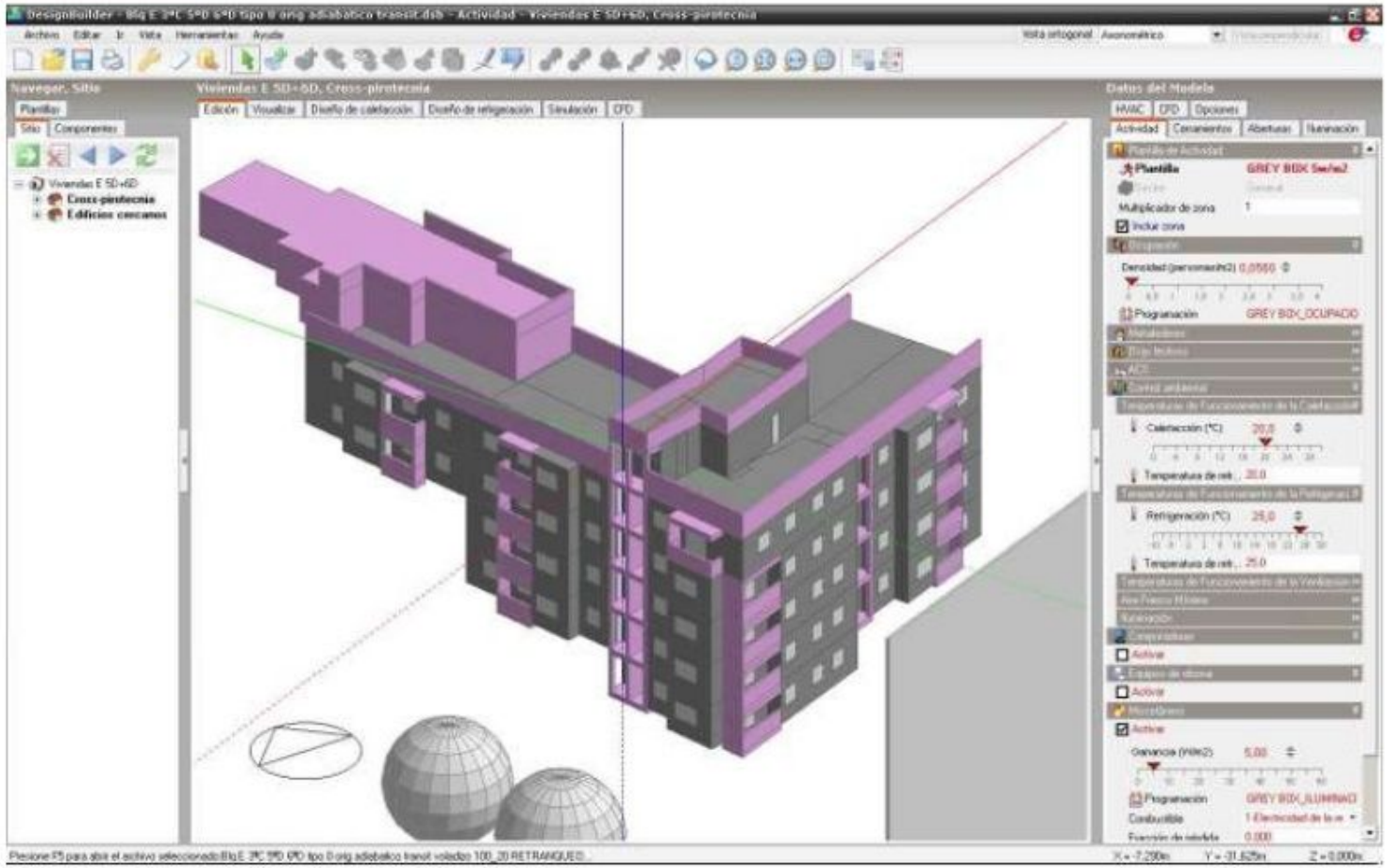
Accurate daylighting calculations

integrated generation of illuminance reports through Radiance



DesignBuilder Packages for Architects

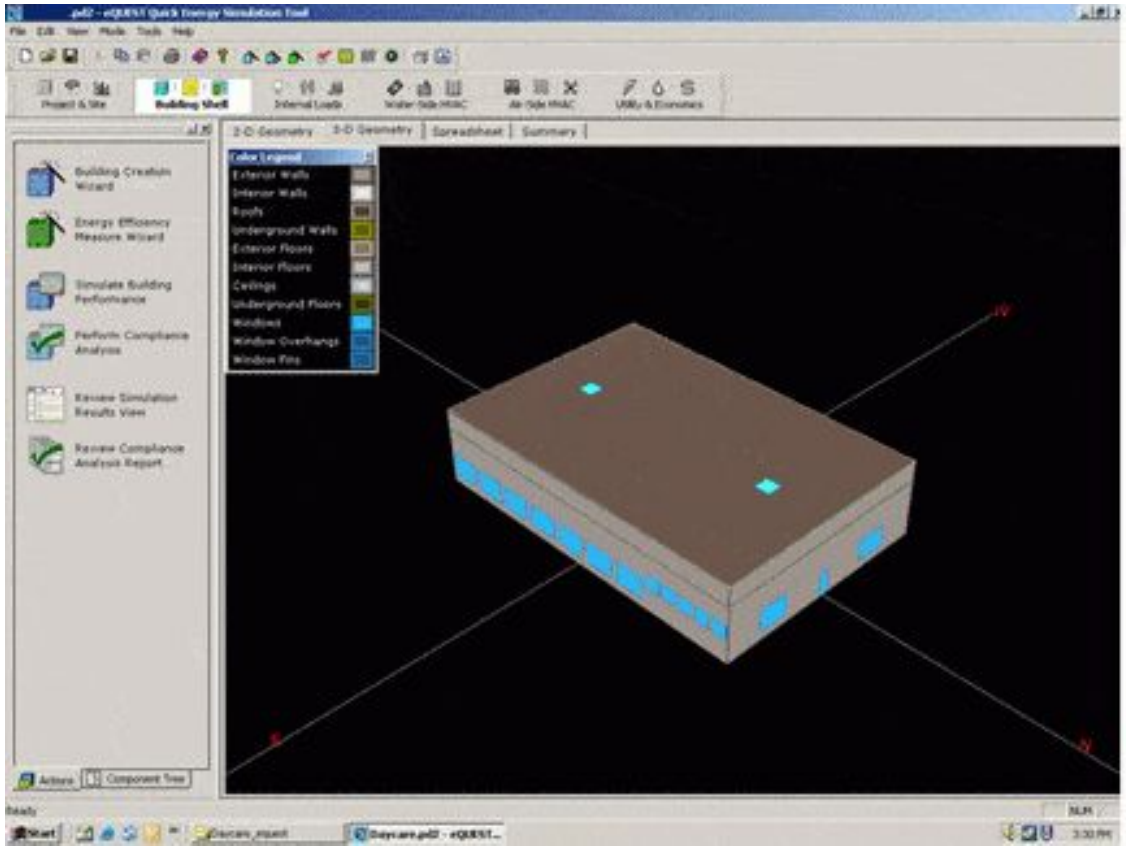
Import BIM models from Revit, SketchUp etc

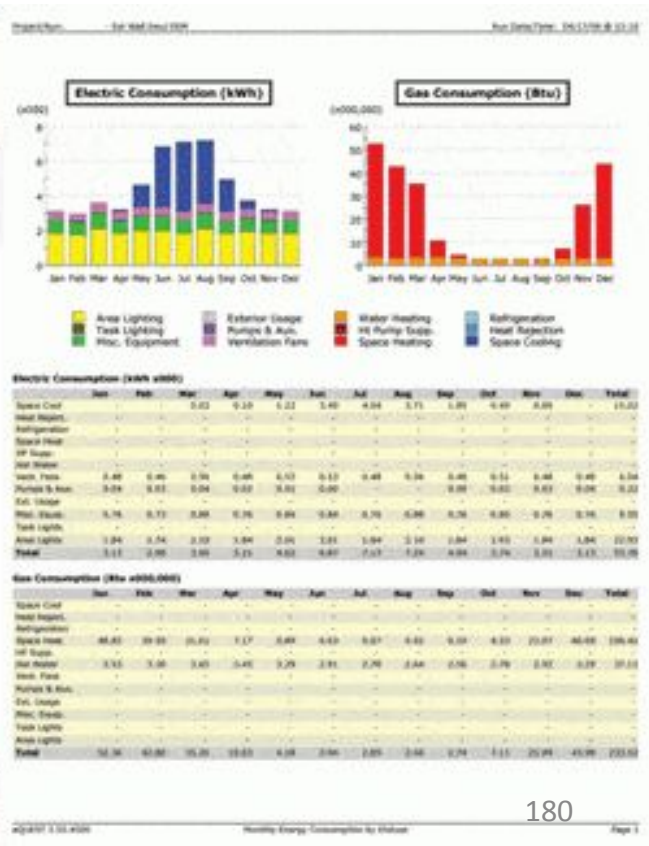


eQuest

Imagine a building energy simulation tool comprehensive enough to be useful to ALL design team members, yet so intuitive ANY design team member could use it, in ANY or ALL design phases, including schematic design. eQUEST is well named because it provides something the you've been looking for, but have been unable to find … a sophisticated, yet easy-to-use building energy analysis tool. With eQUEST, you'll be able to provide professional-level results in an affordable level of effort.

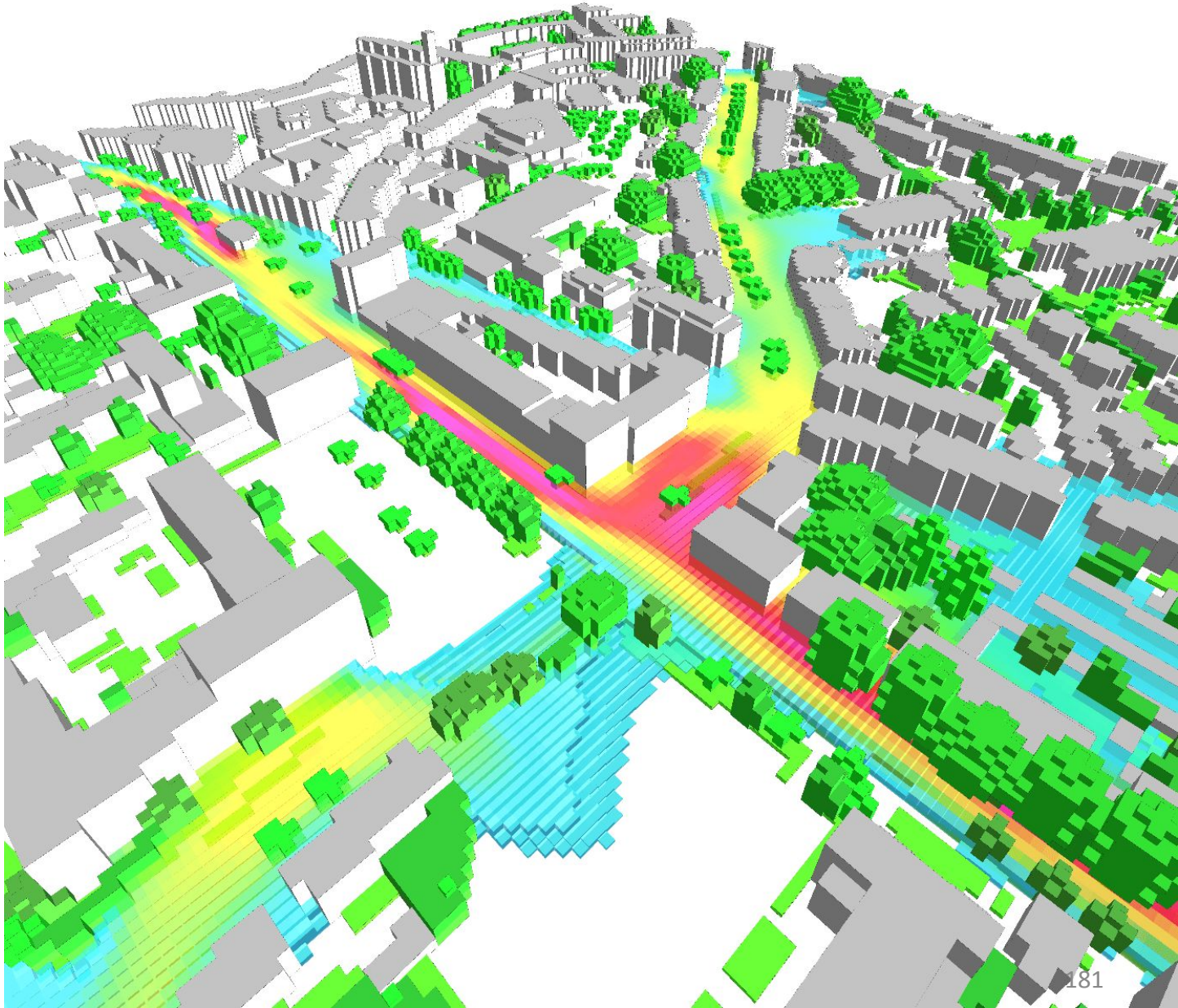
-Daylight





ENVI-met simulation

urban spaces master plans, physical planning morphology and help to draw a picture about the role of built environment elements, materials and vegetation on pedestrian perception and thermal comfort



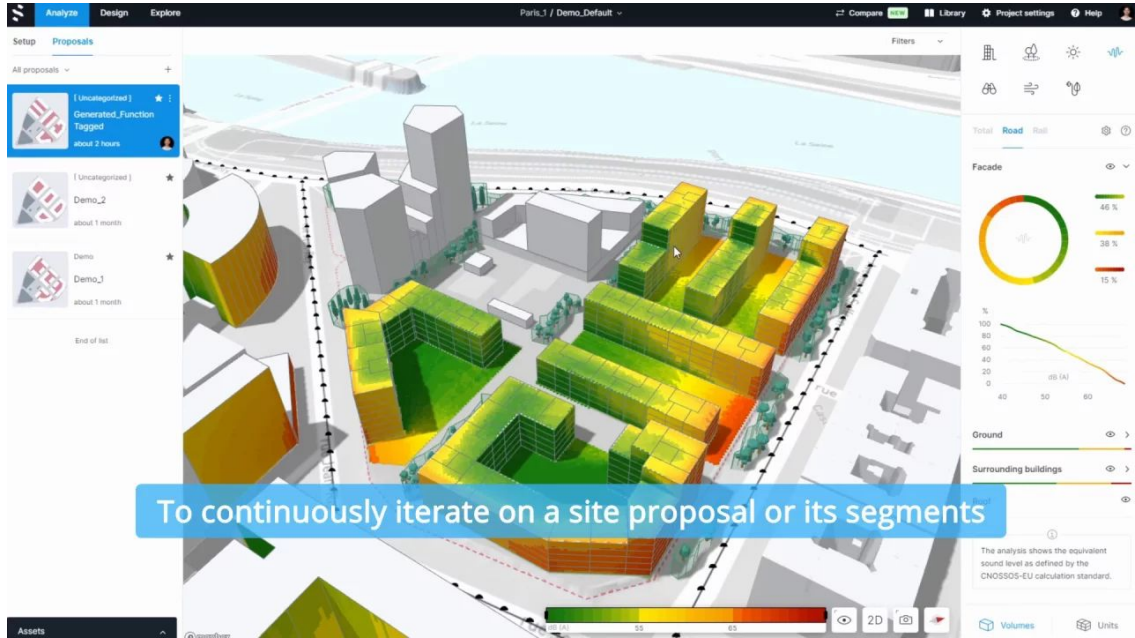
- Spacemaker ai

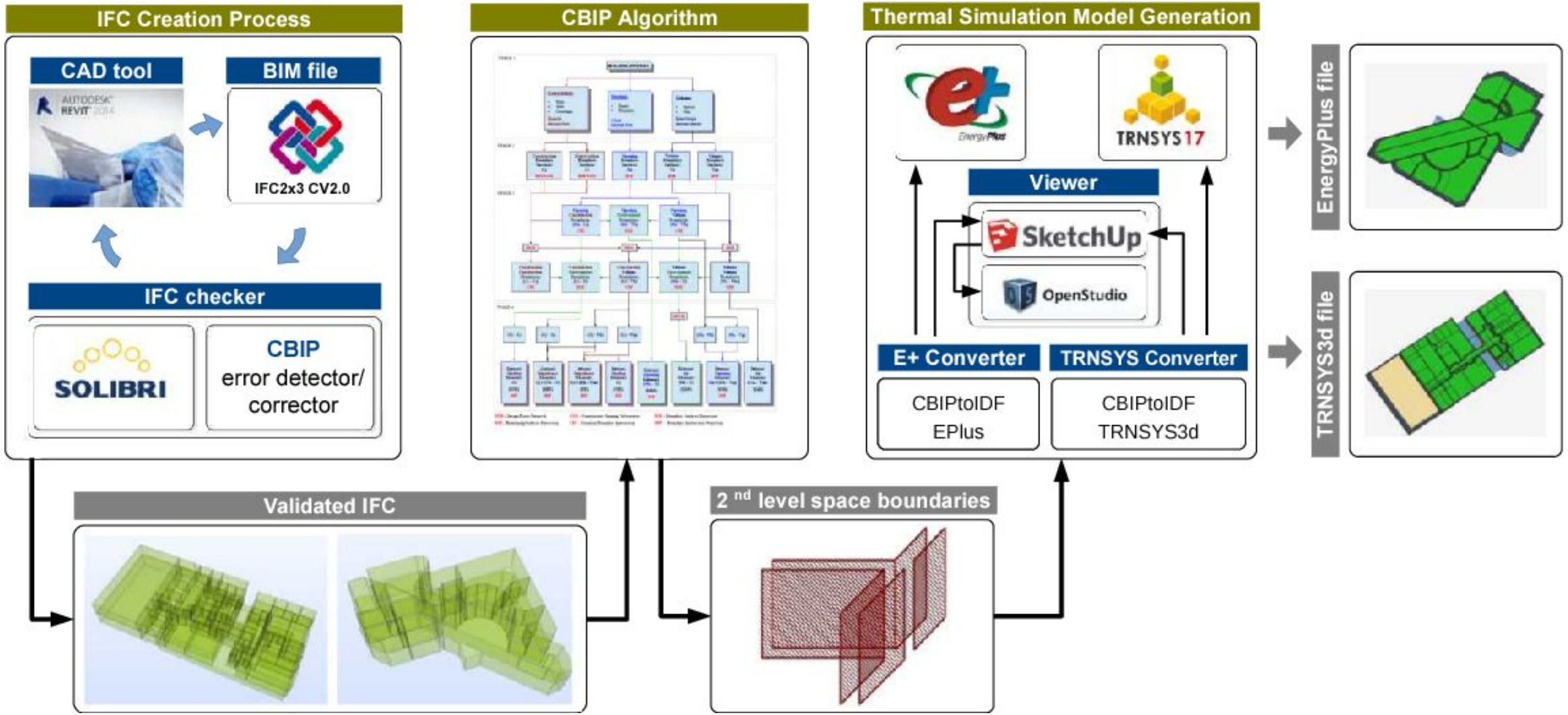
Spacemaker ، أحد منتجات Autodesk ، هو برنامج ذكاء اصطناعي قائم على السحابة ،

يمكّن الفرق من التعاون وتحليل وتصميم المواقع العقارية. مخاطر اقل. مشاريع أسرع. منازل أفضل.

https://www.spacemakerai.com/

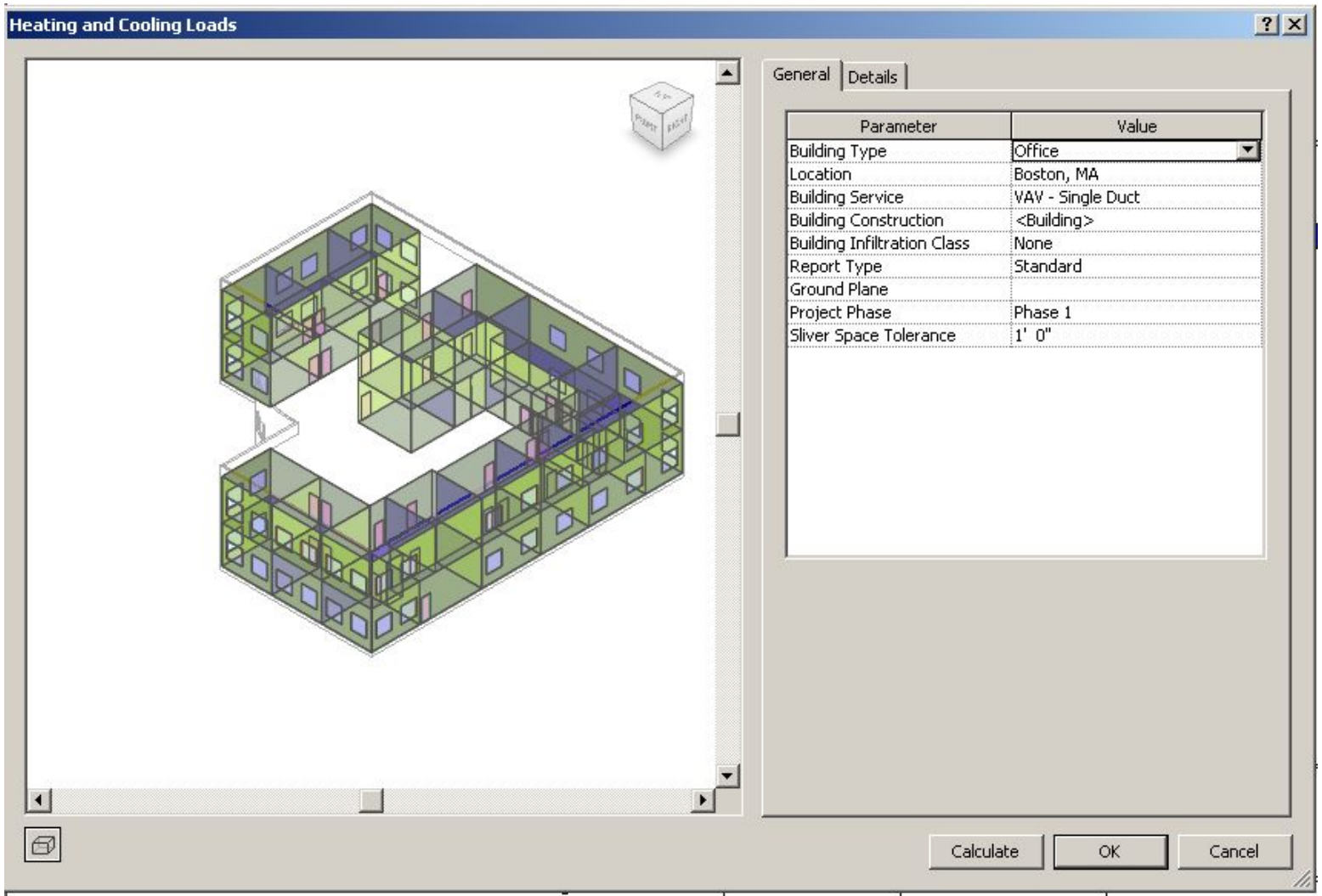
https://www.youtube.com/watch?v=jy15qucUtr0




IFC Creation Process
CAD tool
BIM file
IFC2x3 CV2.0
IFC checker
SOLIBRI
CBIP
error detector/
corrector
CBIP Algorithm
Thermal Simulation Model Generation
TRNSYS 17
Viewer
SketchUp
OpenStudio
E+ Converter
TRNSYS Converter
CBIPtoIDF
EPlus
CBIPtoIDF
TRNSYS3d
EnergyPlus file
TRNSYS3d file
Validated IFC
2 nd level space boundaries

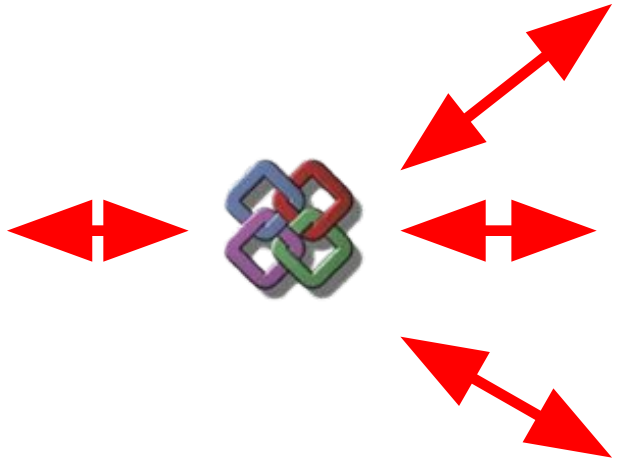
Analytical Model Derived from gbXML

GREEN BUILDING XML



Data Sharing via IFC

IFC platform provides a bi-directional data link to major energy analysis software



EnergyPlus

square one SOFTWARE

BIM model

Energy analysis applications

gbXML Support

- HVAC/Energy
  - CADLine
    - Cymap
  - Carrier
    - Hourly Analysis Program (HAP)
  - DOE-2.2 & eQuest (via GBS)
  - Elite Software
  - EnergyPlus (via GBS)
  - Energy Soft*
  - Environmental Design Solutions Ltd.
    - Tas
  - IES, Ltd.
    - IES <Virtual Environment>
  - Trane
    - TRACE 700

- CAD/BIM
  - Autodesk
    - AutoCAD Architecture & MEP
    - Revit Architecture & MEP
    - Green Building Studio (GBS)
  - Bentley
    - Architecture
    - Building Mechanical Systems
    - Speedikon Architectural
  - Google
    - SketchUp
  - Graphisoft
    - ArchiCAD
    - Mac and Windows

```
<?xml version="1.0" encoding="UTF-16"?>
<gbXML useSIUnitsForResults="true" temperatureUnit="C" lengthUnit="Meters" areaUnit="SquareMeters" volumeUnit="CubicMeters" version="0.37" xmlns="http://
 <Campus id="aim0002">
  <Location>
   <StationId IDType="WMO">188144_2006</StationId>
   <ZipcodeOrPostalCode>00000</ZipcodeOrPostalCode>
   <Longitude>31.37504</Longitude>
   <Latitude>30.12373</Latitude>
   <Elevation>74.0664</Elevation>
   <CADModelAzimuth>0</CADModelAzimuth>
   <Name>30.1237335205078,31.3750400543213</Name>
  </Location>
  <Building buildingType="Office" id="aim0013">
   <StreetAddress>30.1237335205078,31.3750400543213</StreetAddress>
   <Area>2250.42</Area>
   <Space zoneIdRef="aim0367" lightScheduleIdRef="aim0422" equipmentScheduleIdRef="aim0422" peopleScheduleIdRef="aim0428" conditionType="HeatedAndC
    <PeopleNumber unit="NumberOfPeople">0.6687227</PeopleNumber>
    <PeopleHeatGain unit="WattPerPerson" heatGainType="Total">131.882</PeopleHeatGain>
    <PeopleHeatGain unit="WattPerPerson" heatGainType="Latent">58.61422</PeopleHeatGain>
    <PeopleHeatGain unit="WattPerPerson" heatGainType="Sensible">73.26777</PeopleHeatGain>
    <LightPowerPerArea unit="WattPerSquareMeter">10.76391</LightPowerPerArea>
    <EquipPowerPerArea unit="WattPerSquareMeter">13.99308</EquipPowerPerArea>
    <Area>19.10636</Area>
    <Volume>64.96163</Volume>
    <PlanarGeometry>
     <PolyLoop>
      <CartesianPoint>
       <Coordinate>43.78491</Coordinate>
       <Coordinate>-115.9831</Coordinate>
       <Coordinate>1.95</Coordinate>
      </CartesianPoint>
      <CartesianPoint>
       <Coordinate>46.29332</Coordinate>
```

Sustainable Development Acronyms

RO (Renewable Obligation)
EU ETS (EU Emissions Trading Scheme)
CRC (Carbon Reduction Commitment)
FIT (Feed in Tariff)
RHI (Renewable Heat Initiative)
CCL (Climate Change Levy)
ECA (Enhanced Capital Allowances)
Part L (Building Regulations)
ZCH (Zero Carbon Homes)
CERT (Certified Emission Reduction Target)
CESP (Community Energy Saving Programme)
EPCs (Energy Performance Certificates)
DECs (Display Energy Certificates)
EPBD (Energy Performance of Building Directive)
CCA (Climate Change Act)
EU RED (EU Renewable Energy Directive)

LEED (Leadership in Energy and Environmental Design)
BREEAM (BRE Environmental Assessment Method)
CEN TC350 (EC Committee for Standardisation Technical Committee)
SAP (Standard Assessment Procedure for Energy Rating of Dwellings)
LCA (Life Cycle Assessment)
SBEM (Simplified Building Energy Model)
GHG (Greenhouse Gases)
PAS 2050 (Publicly Available Specification)
CSH (Code for Sustainable Homes)
RICS NRM (New Rules of Measurement Part 3)
ISO 15686 (International Standards Organisation Part 5)
BS58455 (British Standard 58455)


MASDAR

Case Study

MASDAR

- Funded by Mubadala Development Company
- Designed by Foster + Partners
- Powered entirely on solar energy and other renewable energy sources
- Zero-carbon, zero-waste ecology
- Abu Dhabi Future Energy Company (ADFEC)
- Projected to cost US$22 billion
- Started in 2006,
- First phase 2009
- 2.3 sq mi
- 50,000 people
- 1,500 businesses

Case Study

MASDAR

- Masdar Institute of Science and Technology (MIST)
- Automobiles will be banned within the city
- Public mass transit and personal rapid transit systems
- City will be walled, to keep out the hot desert wind
- Narrow, shaded streets that will also funnel breezes
- Partners include through the Clean Tech Fund, GE, BP, Royal Dutch Shell, Mitsubishi, Rolls-Royce, Total S.A., Mitsui and Fiat

Case Study

MASDAR

- Power Sources
- 40 to 60 megawatt solar power plant, built by the German firm Conergy (construction activity)
- Larger facility and additional photovoltaic modules will be placed on rooftops to provide supplemental solar energy totaling 130 megawatts
- Wind farms will be established outside the city's perimeter capable of producing up to 20 megawatts
- Geothermal power
- Hydrogen power plant
- The city will not produce enough energy to power itself at night
- Import gas-fired power from Abu Dhabi’s grid
- Carbon accounting by exporting excess solar power to the grid during the day

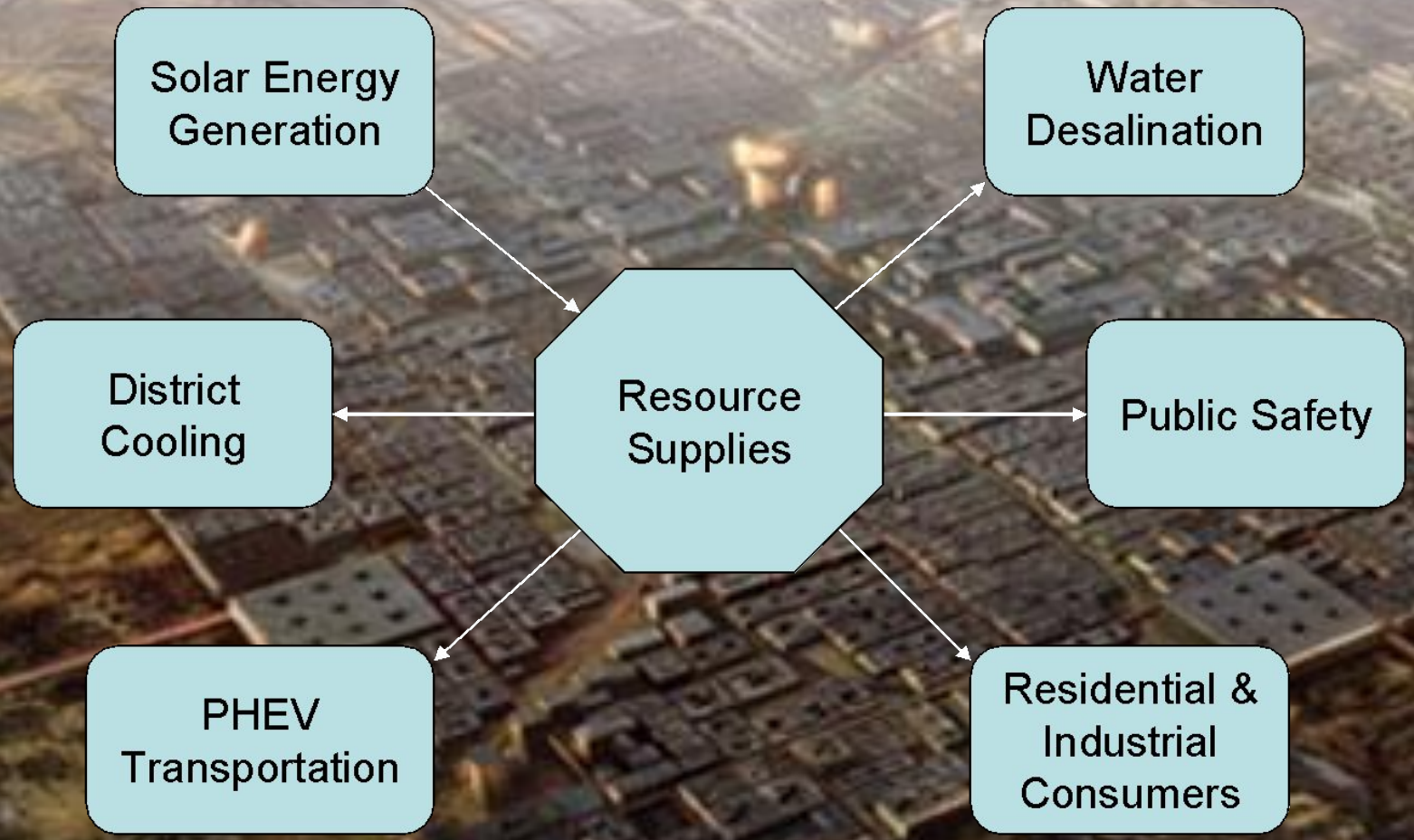
Case Study

MASDAR

- Water
  - Solar-powered desalination plant
  - 60 percent lower water needs than similarly sized communities
  - 80 percent of the water used will be recycled
  - Attempt to reduce waste to zero
  - Biological waste will be used to create nutrient-rich soil and fertilizer
  - Waste incineration as an additional power source
  - Recycle

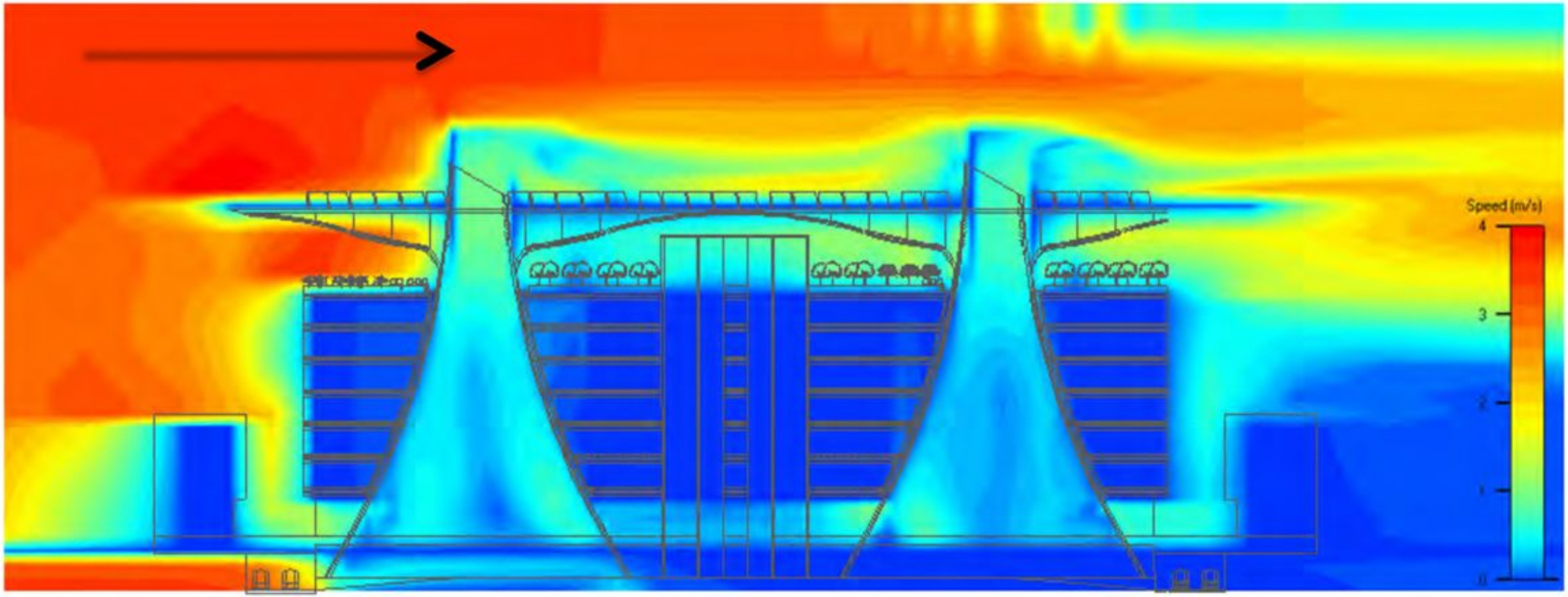
masdar-headquarters

MASDAR – A Net-Zero City (2008)

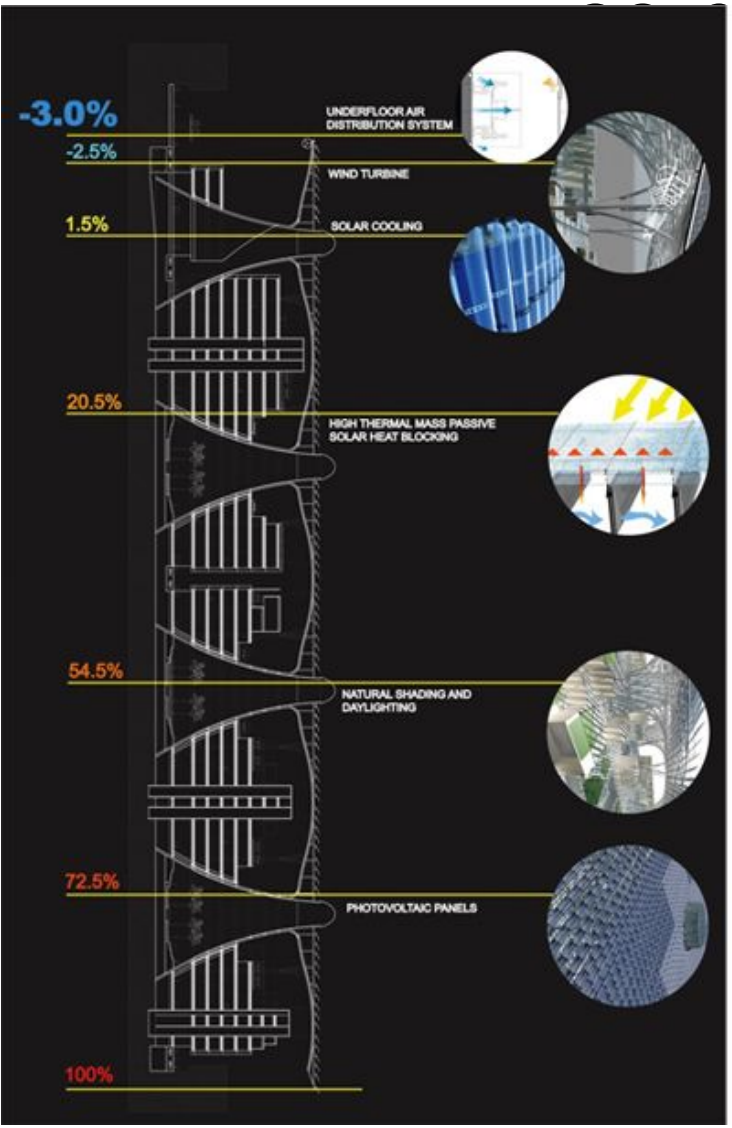


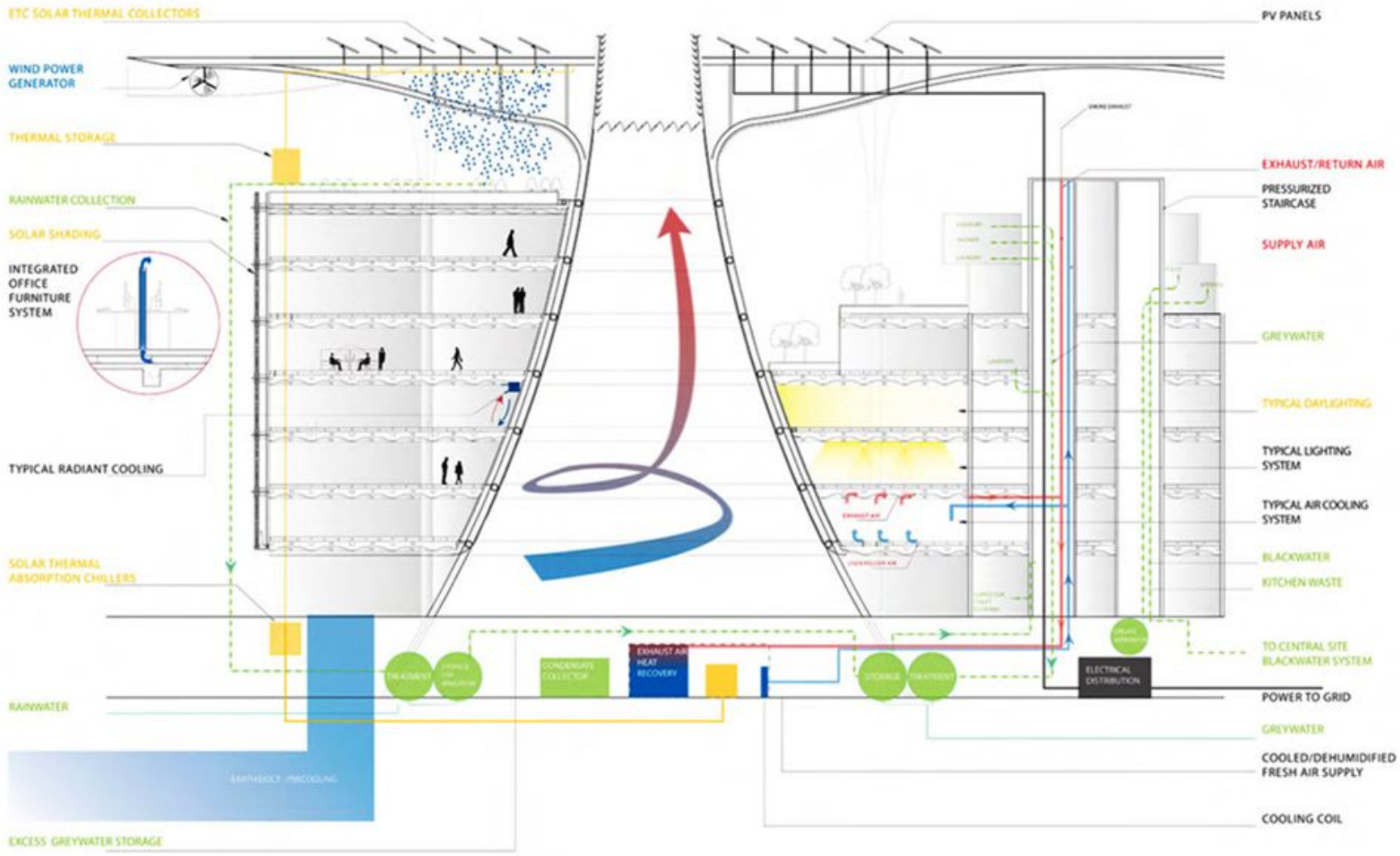
Question: How to allocate resources during a sandstorm?

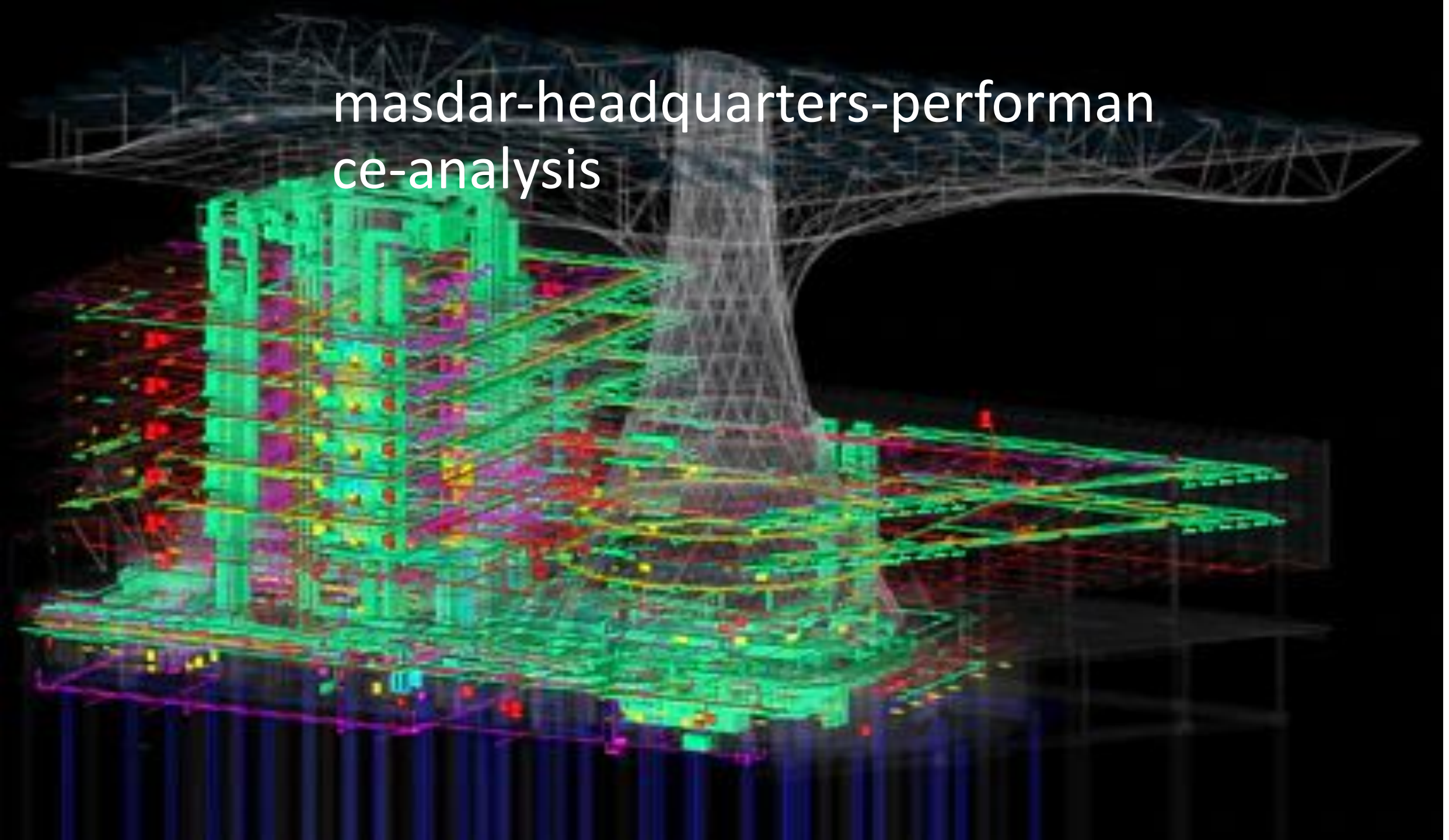
masdar-hq-ventilation-strategy



masdar-hq-sustainability-strategi






masdar-headquarters-performan
ce-analysis

Case Study

MASDAR SYSTEMS

- **Building operation**
- Electrical generation and distribution
- Electrical energy meters
- Water meters
- Mechanical systems
- Public health systems
- Lighting control system
- Automated shading system
- Automated atrium roof lights
- Vertical transportation
- Public address system
- Digital signage system
- Sun tracking system
- Irrigation system
- Water features
- Information portal system
- Freight tracking RFID system

- Personnel RFID system
- MASDAR RFID tracking system
- Ventilation system for catering facilities
- Kitchen equipment
- Point of sale system
- Waste system
- Audio visual systems
- Library data base and alarm system
- Automated book storage facility
- **Transportation**
- PRT - Management centre
- PRT - Security system
- PRT - Ticketing system
- Vehicle management system
- LRT - Light Rail Transit System

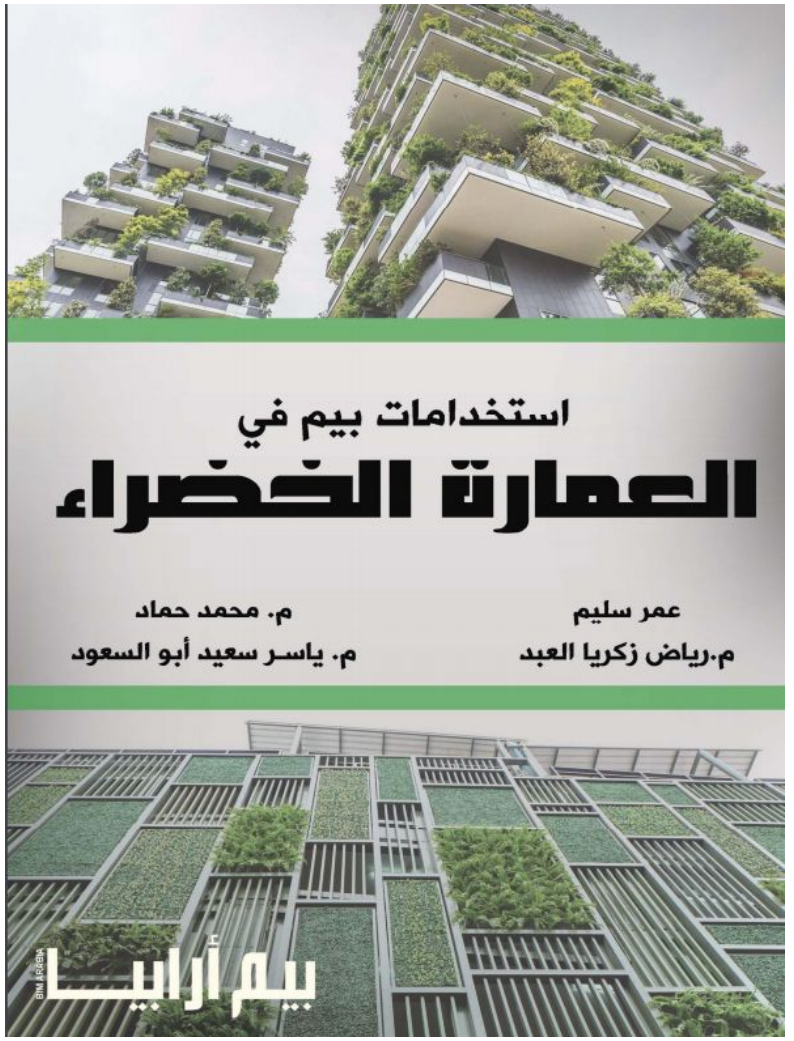
Case Study

MASDAR SYSTEMS

- **Life Safety and Security**
- Seismic monitoring
- Structural anti-corrosion monitoring
- Fire detection/alarm system
- Fire Suppression systems
- Intruder detection system
- Closed circuit television system
- Access control system
- Emergency lighting system
- Oxygen depletion monitoring system
- Refrigerant leak detection system
- Water leak detection system
- Disabled refuge telephone system
- Fire fighters telephone system
- Smoke extract system
- Fire pump
- Sump pumps

استخدامات https://archive.org/details/green-bim
البيم في العمارة الخضراء

https://www.youtube.com/playlist?list=PLNMim060_nUJRgifCygsgxKSnMp9b9cwc



OMAR SELIM

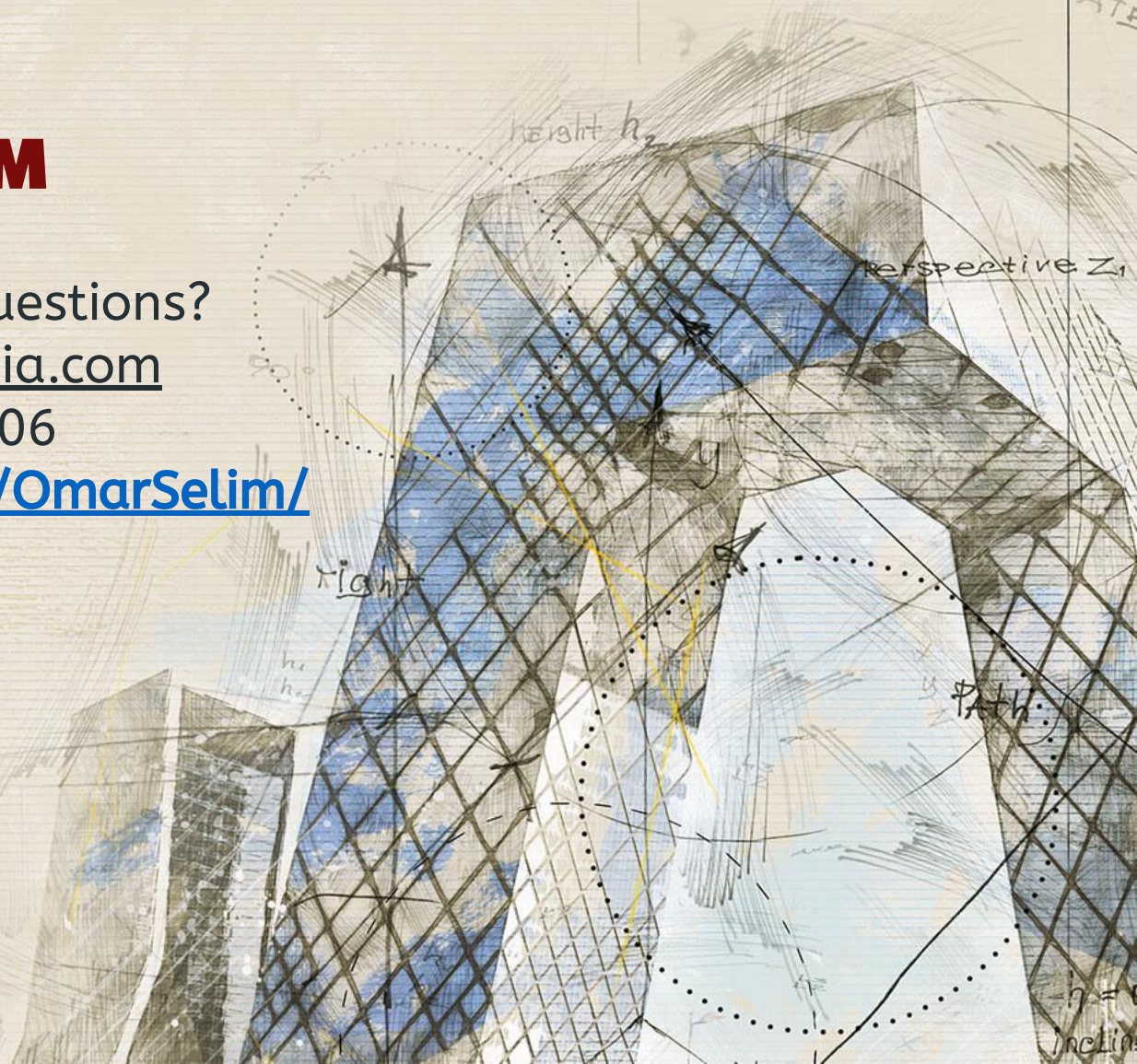
BIM Manager

Do you have any questions?

oselim@bimarabia.com

+97477840306

https://bimarabia.com/OmarSelim/



omrselm

Omar Selim

BIMarabia